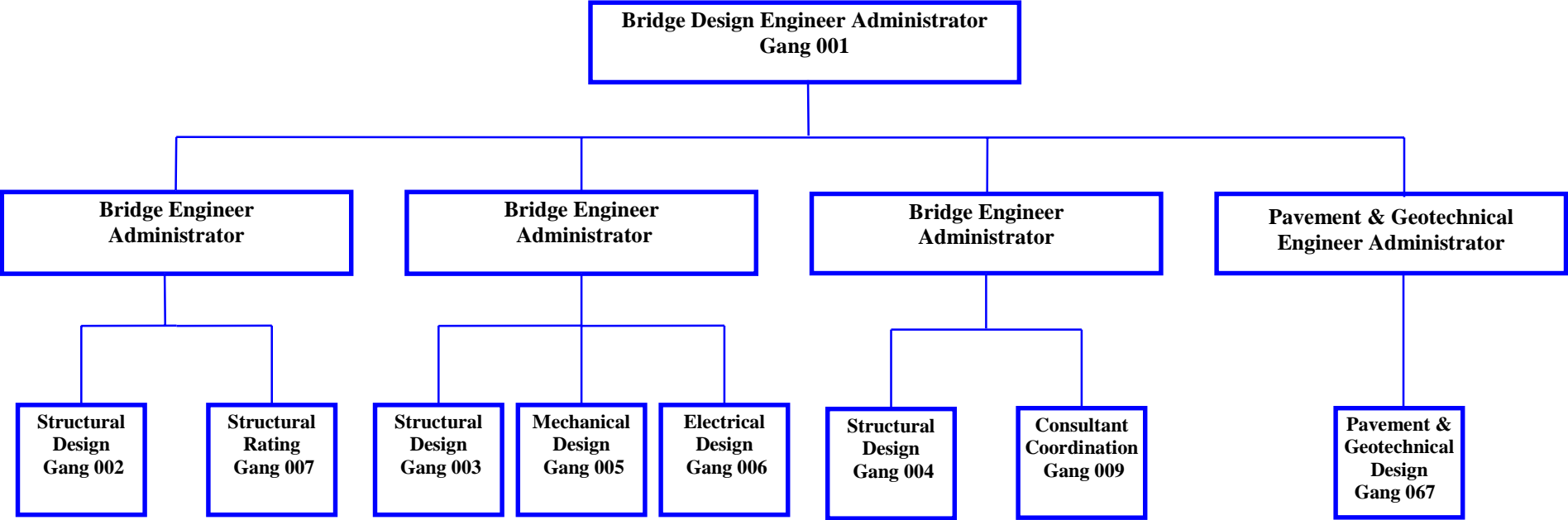


BRIDGE DESIGN ORGANIZATION CHART



Geotechnical Analysis

GENERAL:

Normally, the location, number, and depth of soil borings will be recommended by the Geotechnical Design Section. The boring request form on the page 19 shall be used to order boring and consolidation tests through our Pavement and Geotechnical Design Section. If slope stability analysis is needed this should also be discussed and requested at this time.

For borings done in-house, three (3) sets of plans with the information described in items "1 through 6" listed below should be transmitted to our Pavement and Geotechnical Design Section. Upon receipt of this information, the Pavement and Geotechnical Design Section will order the boring logs & any additional soil information as deemed necessary for the project, including a fill height recommendation.

Some Consultant contracts require the Engineer to furnish the boring logs and test reports. For those contracts, items "1 through 6" listed below are to be submitted to the Department for approval prior to obtaining borings.

There will be some projects in which sufficient existing foundation information is available, thus eliminating the need for additional borings and foundation studies. It will be the responsibility of the Project Coordinator to request this information in writing.

Boring logs shall be included in the plan-in-hand drawings. However, in some cases, when they are not available, plan-in-hand field inspections may be made without boring logs. The boring logs shall be required as a part of the preliminary bridge plans in final form. Correlation of boring logs to actual elevation will be required and will be the responsibility of the Engineer.

The Engineer is to obtain approval from the Department for all foundation (roadway and bridge) design criteria to be used on any project, prior to submittal of preliminary plans. This will include foundation types and lengths (footings, piers, piles, drilled shafts, etc.), pile supported approach slabs, fill heights, retaining wall and sheet pile wall types and consolidation criteria (surcharge, wick drains, etc.)

Foundation studies can change structures from culverts to bridges or vice-versa. Also, the type of substructure and superstructure can be changed by these foundation studies.

Preliminary plans will show controlling fill heights as determined by or approved by the Department.

A foundation report may be required in special cases. The extent of bridge foundation studies, embankment studies, and format for the soil report is to be approved by the Department. This work should be completed and approved prior to submittal of preliminary bridge plans in plan-in-hand form.

The following listed information shall be furnished when requesting borings to be done through the DOTD Pavement & Geotechnical Design Section or if borings are to be obtained through consultant contract procedures:

1. Title sheet or vicinity map to locate projects.
2. Typical section of proposed embankment showing crown width and proposed side slopes.
3. Plan and profile of surveyed alignments and preliminary structure layout in plan and profile. (Submit plan sheets in a 11" X 17" format).
4. Plans to show approximate boring locations and recommended depths.
5. Type of structure being considered.
6. Fill heights and/or depth of cuts at bridge ends.

BORING REQUEST FORM
(one boring request form per site)

PROJECT INFORMATION

Construction No.: _____ Engineering No.: _____ Parish: _____
Project Name: _____
Route No: _____ Structure No.: _____ FAP No.: _____
Letting Date: _____ Project Alignment: ☐ Original ☐ New
Prelim. Plan Date: _____ Project Units: ☐ English ☐ Metric

STRUCTURAL INFORMATION

Bridge Length: _____ Pile Size and Type: _____ Pile Load: _____
Abutment Fill Height (Begin Bridge): _____ (End Bridge): _____ Bridge Width: _____
Projected Scour Elevation: _____
Are Old Borings Available From This Site? ☐ YES ☐ NO If YES, Please Include With Your Submittal
Will There Be Roadway Embankment? ☐ YES ☐ NO If YES, Complete the Following Information
☐ New Embankment or ☐ Widening Embankment Stations(Begin): _____ (End): _____
Height at Beginning Station: _____ End Station: _____
Will There Be Embankment Walls? ☐ YES ☐ NO If YES, Complete the Following Information
☐ MSE Wall or ☐ Sheet Pile Wall Stations(Begin): _____ (End): _____
Height at Beginning Station: _____ End Station: _____
Are Cross-Sections Available? ☐ YES ☐ NO If YES, PLEASE PROVIDE COPIES
Special Comments: _____
Structural Information Completed By: _____ Date: _____

FIELD & LABORATORY REQUEST

(to be completed by the Pavement and Geotechnical Design Group)

☐ Total Number of Borings Requested: _____
☐ Sampling Frequency:
Standard _____
Continuous _____
☐ Boring Depths: _____

☐ Water Table: _____
☐ Consolidation Testing: _____
☐ Grain Size:

<u>Boring Nos.</u>	<u>Sieve</u>	<u>Hydrometer</u>	<u>Depth</u>
_____	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	_____

☐ Comments: _____
Field & Lab. Request Completed By: _____ Date: _____
⇒ **Required Attachments:** 4 COPIES OF GENERAL PLAN(S) & LOCATION MAPS (Rev. 02/22/01)

battered piles, bent numbers, station of centerline of each bent along profile grade line.

- d) Foundation plans are usually not required for trestle bent type construction. However, complex bridgework may require foundation plans for these type foundations.
- e) Foundation plans are usually required for pier type construction and should include information described in items "a - c" above.
- f) Details and information required to construct the bridge foundations shall be placed in tables for all projects. However, the information furnished in the tables should be properly correlated to the foundation drawings. Also, the tables should be located close to the foundation drawings.
- g) Actual maximum pile or shaft loads shall be shown in the plans for each pier or bent. Maximum soil pressure (dead load, live load) should be shown in the plans for other foundation types such as spread footings and retaining walls.

SPECIAL DETAILS, (spans, girders, bents, piers, footings, approach slabs, joints, bearings, retaining walls, etc.)

1. The design drawings shall include full details showing type of construction details of all structural members, connections, and splices and summary of quantities for each structural item.
2. All the structural drawings shall be to scale.
3. Tables may be utilized for similar structural items and details - provided the information in the tables and the detail drawings are properly correlated.
4. A deformed reinforcing steel summary of quantities is to be provided in the plans (including bar bending details) for each part of the bridge structure (spans, including precast concrete girders⁵, bents, piers, footings, columns, etc.). Dimensions relating to reinforcing steel fabrication are out-to-out of bar. Dimensions relating to reinforcing steel spacing are center-to-center of bar.
5. Listed below is some general information, which should be included in the plans when applicable.
 - a) Camber diagrams for proper fabrication of bridge members and construction of superstructure. Camber diagrams to include separate ordinates for beam dead load and any dead load to be placed upon the member (such as bridge barrier,

⁵ The reinforcing estimated quantities provided for such structure parts as precast-prestressed concrete members paid for per linear meter are for information purposes only. In such case as this, estimated quantities should be provided for a example (or nominal) members of each type.

curb, handrail, wearing surface) after the deck concrete is poured. Final camber ordinates must include correction for vertical curves.

- b) End and intermediate superstructure diaphragms to be located relative to centerline of joint.
- c) Bearing assemblies are to be fully detailed and the finished bearing elevation of each bearing are to be shown (in tables or special details).
- d) Beam dead load reactions for all bridge structures.
- e) Live load and dead load moments and shears for all steel spans. For curved steel spans show LL + DL moments and shears at 20th points.

STANDARD BRIDGE PLANS AND DETAILS

The Bridge Design Section maintains standard plans and details for various structural bridge members, permanent signing and guardrail. These standard bridge plans and details may be obtained upon written request to the Bridge Design Engineer for incorporation into any DOTD project. These standard plans and details should be included in the final plans when they can be used. For more information, refer to chapter 8.

MOVABLE BRIDGES

The final plans for mechanical drawings shall show complete layouts of the mechanical systems. All parts to be completely detailed and all commercial equipment shall be completely specified. A complete "bill of materials" shall be included in the mechanical plans. Since the Department has its own method of presenting mechanical drawings, the Engineer should become familiar with the detail practice of the Bridge Design Section prior to beginning any work. Details for the mechanical system should be similar to details usually presented in mechanical shop drawings.

ELECTRICAL PLANS

1. The final plans shall include complete electrical plans, including conduit and equipment layout; control schematics; and complete details of all fabricated, assembled, or otherwise made-up parts; and complete specifications of all commercial equipment and apparatus. Furnish complete design of electrical and illumination systems and of all components. Since the Department has its own method of presenting the wiring diagrams, the Engineer should become familiar with the detail practice of the Bridge Design Section prior to beginning any work.

2. The plan shall include complete power and control elementary wiring diagrams with all conductors and equipment and apparatus identified; complete conduit and wire layout; detail drawings and equipment list.
3. When necessary, written special provisions shall be supplied.
4. The Engineer shall be responsible for obtaining written confirmation from the utility company as to their ability to supply proposed load.

PERMANENT SIGNING PLANS

1. For projects requiring permanent signing, separate detail sheets showing the signing layout, signing quantities and specific signing details are required. The permanent signing is normally coordinated through our Geometric Design Section.
2. Permanent signing standard details are maintained by the Bridge Design Section. These details include small ground signs (breakaway) and large overhead signs. Structure mounted special support details (bridge, median barrier, retaining wall, etc.) for large overhead signs are not shown on the standard sign details; these must be designed and detailed on an individual basis for each specific sign when required.

Bridge Plans In Final Form (A.C.P's submittal procedure)

1. The Engineer shall submit "reproducibles" of the "Advance Check Prints" (95% Final Plans) along with any required special provisions and a construction cost estimate for review and comments. Each sheet must be stamped by a Civil Engineer registered by the State of Louisiana.
2. The plans, specifications, and estimates are to be reviewed by the Department of Transportation and Development and others that may be involved such as the Federal Highway Administration, etc. The Department will advise the Engineer of all comments, errors and omissions relative to the plans, specifications, and estimate; which shall be revised and/or corrected by the Engineer. Please be advised that this is only a cursory check and the Engineer is responsible for the accuracy and completeness of the plans.
3. The Engineers are to work closely with the Department in order that the final plans, specifications and estimates may be completed and ready for the proposed contract letting date.

Construction Specifications

- a) Latest approved Louisiana DOTD Standard Specifications for Roads and Bridges.
- b) Special provisions and supplemental specifications.

Welding Specifications

Welding of structural steel, steel pipe and tubular members, reinforcing steel and aluminum alloys shall conform to Section 815 of the latest edition of the DOTD Standard Specifications for Roads and Bridges.

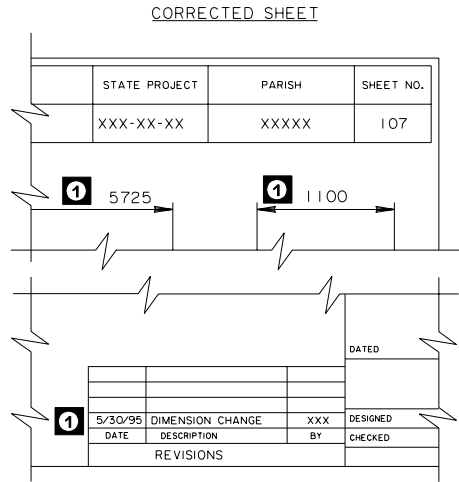
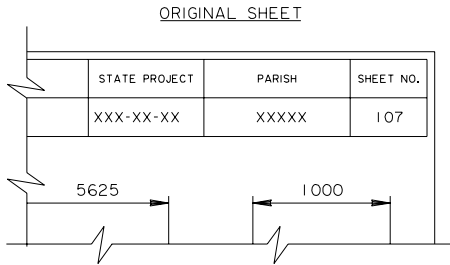
Loading

- a) Dead Load - Calculated weight of structure plus 600 N/m^2 future wearing surface. Dry weight of earth 20 kN/m^3 ; equivalent fluid pressure 9.8 kN/m^3 .
- b) Live Load - Design Live Load shall be AASHTO designation MS-18 Truck or Lane Load or HST-18(M) Truck Load, whichever governs except that HST-18(M) shall generally not be used for local roads and streets except where heavy truck traffic exists. Alternate Military Load shall be applied on the Interstate System. Only MS-18 Truck or Lane Loading shall be used for fatigue design when applicable. For two design traffic lanes, the load lanes may be adjacent to and touching one another, causing the wheel loads to be 1.2 meters apart.
- c) Wind Loads - Wind forces are to be applied in accordance with the AASHTO Specifications.
- d) Seismic Loading must be investigated in accordance with the AASHTO Specifications (Guide Specifications for Seismic Design of Highway Bridges).
- e) Other loads such as temperature and stream forces shall be in accordance with the latest AASHTO specifications.

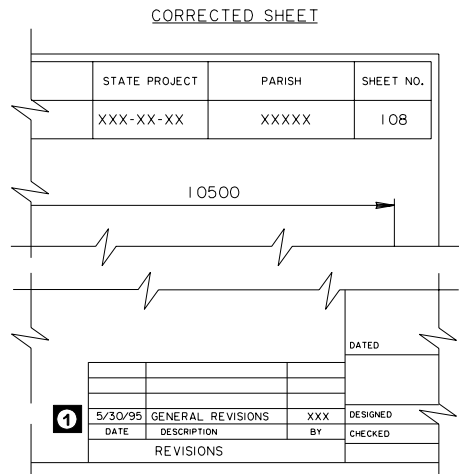
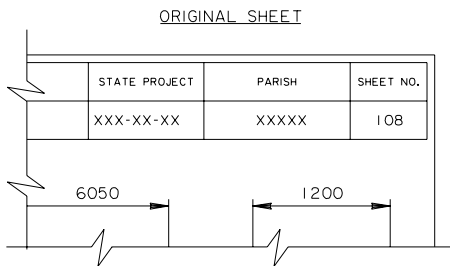
Materials and Required Strengths

- a) Reinforcing Steel - Reinforcing steel bars shall be Grade 420.

1. IF MINOR REVISIONS ARE NEEDED, MAKE CHANGES ON THE ORIGINAL SHEET.
ERASURES ARE ALLOWED. FOR EXAMPLE:



2. IF MAJOR REVISIONS ARE NEEDED, DESTROY THE ORIGINAL SHEET AND MAKE CHANGES ON THE NEW SHEET FOR EXAMPLE:



3. SHOW REVISION NUMBER (1) FOR ALL REVISED SHEET NUMBERS (INCLUDING TITLE SHEET NUMBER) IN THE TITLE SHEET REVISION BLOCK.
4. IF QUANTITIES ARE INVOLVED, REVISE COST ESTIMATE.
5. THE TITLE SHEET REVISION BLOCK MUST BE SIGNED BY THE CHIEF ENGINEER.
6. TRANSMIT A SET OF PRINTS AND A COPY OF ESTIMATE TO CONTRACTS AND SPECIFICATIONS SECTION.
7. RETURN THE REVISED PLANS TO GENERAL FILES.

REVISION PROCEDURE

1. IF A MINOR PLAN CHANGE IS REQUIRED, MAKE THE CORRECTIONS ON THE ORIGINAL SHEET. (NO ERASURES!) NOTE THE CORRECTIONS WITH A "BUG" (Δ) AND SHOW IT IN THE REVISION BLOCK. FOR EXAMPLE:

STATE PROJECT		PARISH		SHEET NO.	
XXX-XX-XX		XXXXX		107	

5625 Δ 5725

PLAN CHANGE AND/OR SPECIAL AGREEMENT

DATED			
5/30/95	DIMENSION CHANGE	XXX	DESIGNED
DATE	DESCRIPTION	BY	CHECKED
REVISIONS			

2. IF MAJOR PLAN CHANGE, MAKE CORRECTIONS ON NEW SHEET, ADD "A" TO SHEET NUMBER, AND STAMP "VOID" ON ORIGINAL SHEET. FOR EXAMPLE:

ORIGINAL SHEET

STATE PROJECT		PARISH		SHEET NO.	
XXX-XX-XX		XXXXX		108	

6050

VOID

NEW SHEET

STATE PROJECT		PARISH		SHEET NO.	
XXX-XX-XX		XXXXX		108A	

10 500

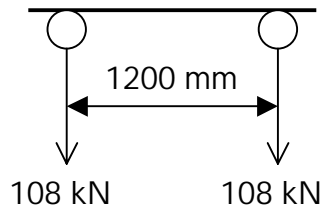
PLAN CHANGE AND/OR SPECIAL AGREEMENT

DATED			
5/30/95	REPLACES SHT. NO. 108	XXX	DESIGNED
DATE	DESCRIPTION	BY	CHECKED
REVISIONS			

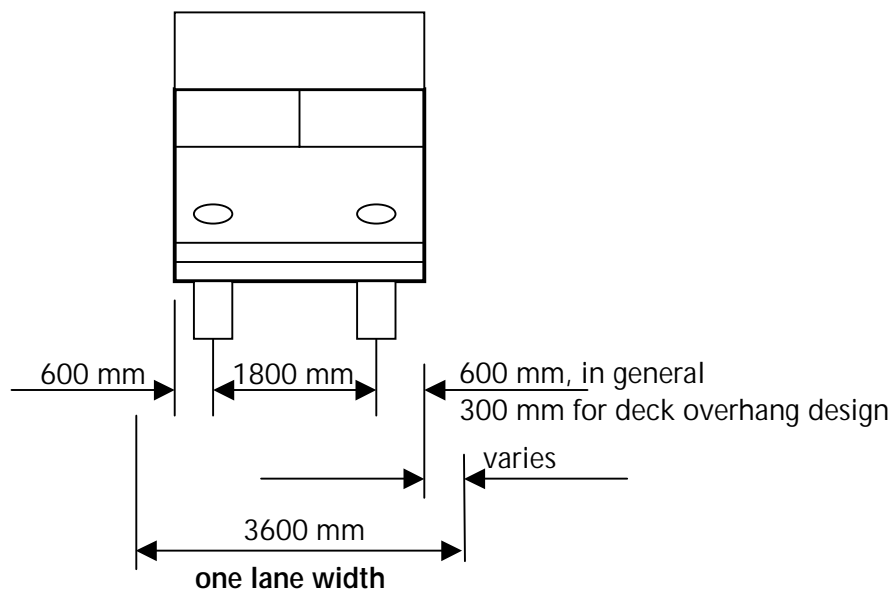
3. DON'T SHOW ANYTHING ON THE TITLE SHEET.
4. IF THE CHANGES ARE SIGNIFICANT, SHOW QUANTITY CHANGES ON BRIDGE SUMMARY SHEET.
5. TRANSMIT 18 HALF-SIZED SETS OF PRINTS OF AFFECTED SHEETS, WITH A MEMORANDUM TO THE CHIEF CONSTRUCTION ENGINEER. TRANSMIT ONE SET OF HALF-SIZED PRINTS TO THE PROJECT ENGINEER, BY COPY OF THE MEMORANDUM. IF CONSULTANTS ARE INVOLVED, SEND THEM A HALF-SIZED SET BY COPY OF THE MEMORANDUM. IF REAL ESTATE AND UTILITIES ARE INVOLVED, FULL-SIZED SETS ARE TO BE TRANSMITTED, 10 TO REAL ESTATE AND 1 TO UTILITIES, BY COPY OF MEMORANDUM.
6. RETURN PLANS TO GENERAL FILES.

PLAN CHANGE PROCEDURES

Military Loading



Transverse View of Loading



Sound Wall Load:

Bridges which require installation of Sound Walls shall be designed to accommodate the appropriate dead, live and wind loads for the required wall height. Dead loads of the wall shall be minimum of 45 kg/m for wall heights up to 3 meters and 90 kg/m for walls greater than 3 meters.

Definition of Terms	30
Design Considerations.....	33
Examples	34
Examples	35
Superelevation Development Options (Sample Plan Sheets)	39
BRIDGE DECK DRAINAGE	41
BRIDGE DECK TRAFFIC MARKERS.....	41
DESIGN CRITERIA FOR CONCRETE SLAB SPANS	43
DESIGN CRITERIA FOR CONCRETE BRIDGE DECKS.....	43
Analysis.....	43
Deck Design Details.....	45
Deck Design Typical Sections	48
Deck Design Table (hard metric conversion).....	49
Deck Design Table (soft metric conversion)	50
DESIGN CRITERIA FOR DECKS OF MOVABLE BRIDGES	51
Vertical Lift Spans.....	51
Swing Spans	51
STEEL GRID FLOORS.....	51
Commentary.....	51
Analysis.....	51
Design Details	52
DECK JOINT.....	52
Design Criteria for Strip Seals	53
Design Example: Prestressed Concrete Girder Spans.....	54
Design Example: Steel Girder Spans.....	55
PRESTRESSED GIRDERS	56
Introduction.....	56
Scope	56
Commentary.....	56
Analysis.....	57
Design Details	60
Applicable Standard Drawings	61
PRESTRESSED GIRDERS WITH DEBONDED STRANDS.....	62
Introduction.....	62
Commentary.....	62
Analysis.....	63

Design Details.....	64
Chart of Span Range Limits for Prestressed Girders	65
Dimensions and Properties of Prestressed Girders	66
Strand Pattern Templates Details.....	68
Strand Properties Table	69
Type I-IV (End & Intermediate Diaphragms)	70
Diaphragm Details (Type BT End and Intermediate Diaphragms).....	71
Diaphragm Details (Type I through IV Continuity Diaphragms)	72
Diaphragm Details (Type BT Continuity Diaphragms).....	73
Diaphragm Reinforcing Steel Details (Type I through BT)	74
Diaphragm Connection Details at Continuity Plugs	75
Diaphragm Concrete Quantities (Type I-BT, End & Intermediate Diaphragm)	76
Diaphragm Concrete Quantities (Type I-BT, Continuity Diaphragm).....	77
GENERAL GUIDELINES FOR STEEL SPANS.....	78
ANALYSIS.....	78
DETAILING.....	79
Haunch Details for Steel Girders.....	84
Stiffeners (Elevation View).....	85
Stiffeners, (Typical Sections Through Girder)	86
Stiffeners, (Lateral Connection Plate at Transverse Stiffeners)	87
Stiffeners, (Longitudinal Stiffeners)(Plan View).....	88
Inspection Handrail for Steel Girders	89
Cross Frames Diaphragms.....	90
DIAPHRAGM CONFIGURATIONS	91
Cross Frames (Typical Details).....	92
Cross Frames (Typical Skewed Diaphragm Connections)	93
STEEL GIRDER OPTIMIZATION	94
FATIGUE DESIGN OF STEEL STRUCTURES.....	95
Introduction	95
Commentary	95
Analysis and Details	95
FRACTURE CRITICAL MEMBERS.....	97
Introduction	97
Commentary	97
Identification	97

Two-Girder Systems	97
Box Girder Bridges, Single Box Design	97
Steel Caps	98
Truss Bridges.....	98
Suspended Span Bridges, Two-Girder Systems.....	98
Analysis.....	98
Details.....	98
GUIDELINES FOR WEATHERING STEEL DESIGN	100
Scupper Drain Details	102
BEARINGS.....	103
RECTANGULAR NEOPRENE BEARING DESIGN	104
Design (Method A).....	105
CORROSION PROTECTION METHODS.....	107
GENERAL	107
Fly ash.....	107
Microsilica	108
Calcium Nitrite.....	108

Examples

Given: $V = 100 \text{ km/h}$

$$R = 600 \text{ m}$$

$$n_c = 0.025 \quad (\text{standard cross-slope})$$

$$e_{\max} = 10\% \quad (\text{DOTD rural standard})$$

$$e = .078 \quad (\text{from AASHTO Table III-10})$$

$$MRS = 1 / 222 \quad (\text{from AASHTO Table III-13})$$

Rotate about centerline

A) two 3.6 m lanes

no shoulders

$$L = 3.6 \text{ m} \quad (\text{distance from rotation line to edge of rotated surface})$$

$$LF = 1.0 \quad (\text{function of L and page 180, AASHTO})$$

run = rise / slope

$$AB = [\text{lane} * n_c / MRS] * LF = 3.6(0.025) 222 (1.0) = \mathbf{0.09(222)} \cong 20 \text{ m (runout)}$$

$$BD = [\text{lane} * e / MRS] * LF = 3.6(0.078) 222 (1.0) = \mathbf{0.28(222)} \cong \underline{62 \text{ m}} \quad (\text{matches Table III-10})$$

$$AD = \text{superelevation transition length} \quad \mathbf{82 \text{ m}}$$

$$g = \text{rise} / \text{run} = (n_c + e) * L / AD = (.025 + .078)3.6 / 82 = \mathbf{0.004522 \text{ m/m}}$$

Remainder of the superelevation diagram geometry can be determined from the **control values**.

B) four 3.6 m lanes

no shoulders

$$L = 3.6 * 2 = 7.2 \text{ m} \quad (\text{distance from rotation line to edge of rotated surface})$$

$$LF = 1.5 \quad (\text{function of L and page 180, AASHTO})$$

$$AB = 3.6 (0.025) 222 (1.5) \cong 30 \text{ m}$$

$$BD = 3.6 (0.078) 222 (1.5) \cong \underline{94 \text{ m}} \quad (\text{matches Table III-10})$$

$$AD = \quad 124 \text{ m}$$

$$g = (0.025 + 0.078)7.2 / 124 = 0.005981 \text{ m/m}$$

Minimum Runoff Lengths may be controlled by the two second rule rather than the Maximum Rate of Slope (MRS) when radii larger than minimum values are used for a given design velocity.

B') same as B, except $R=1200$ m

$$e = 4.3$$

(from Table III-10)

$$BD = [\text{lane} * e / \text{MRS}] * LF = 3.6(.043)222(1.5) = 51.6\text{m}$$

> distance traveled in 2 seconds

$$= \text{time} * \text{velocity} * LF$$

$$= 2 \text{ seconds (100 kph)} 1.5 [1000\text{meters/kilometer}][1 \text{ hour}/3600 \text{ seconds}]$$

$$= 55.6 \text{ meters} * 1.5$$

$$= 84 \text{ m} \quad \{\text{controls}\} \quad (\text{matches Table III-10})$$

$$AB = BD * nc / e = 84 * .025 / .043$$

$$= \underline{48 \text{ m}}$$

$$132 \text{ m}$$

$$g = (.025 + .043) 7.2 / 132 = 0.003709 \text{ m/m}$$

C) two 3.6 m lanes

two 3.0 m shoulders

$$L = 3.6 + 3.0 = 6.6 \text{ m}$$

$$LF = 1.4$$

$$AB = 3.6 (0.025) 222 (1.4) \cong 28 \text{ m}$$

$$BD = 3.6 (0.078) 222 (1.4) \cong \underline{88 \text{ m}}$$

$$AD = 116 \text{ m}$$

$$g = (0.025 + 0.078) 6.6 / 116 = 0.005860 \text{ m/m}$$

Rotate about low gutter

[Page 187 of *A Policy on Geometric Design of Highways and Streets*, 1994 AASHTO, indicates that when rotation is about roadway edge, runoff lengths are similar to those for a centerline rotation with the same roadway width. This is consistent with page 177 where the MRG between profiles of edges of two-lane traveled ways is allowed to double. One way to account for this is by using a lane factor (LF) based on an adjusted length ($L' = \frac{1}{2} L$) when calculating the required runoff length.]

D) two 3.6 m lanes

no shoulders

$$L = \text{lanes} + \text{shoulders} = 2 * 3.6 = 7.2 \text{ m} \quad (\text{dist. from rotation line to edge of rotated surface})$$

$$L' = \frac{1}{2} * L = \frac{1}{2} * 7.2 = 3.6 \text{ m} \quad (\text{corrected width for determining LF for low gutter rotation})$$

$$LF = 1.0$$

(function of L' and page 180, AASHTO)

$$BC = [\text{lane} * nc / \text{MRS}] * LF = 3.6 (0.025) 222 (1.0) = \underline{0.09(222)} \cong 20 \text{ m}$$

$$CD = [\text{lane} * (e - nc) / \text{MRS}] * LF = 3.6 (0.078 - 0.025) 222 (1.0) \cong \underline{42 \text{ m}}$$

$$BD = [\text{lane} * e / \text{MRS}] * LF = 3.6 (0.078) 222 (1.0) = \underline{62 \text{ m}} \quad (\text{matches Table III-10})$$

$$g = [(\text{runout width}) * nc + L(e - nc)] / BD$$

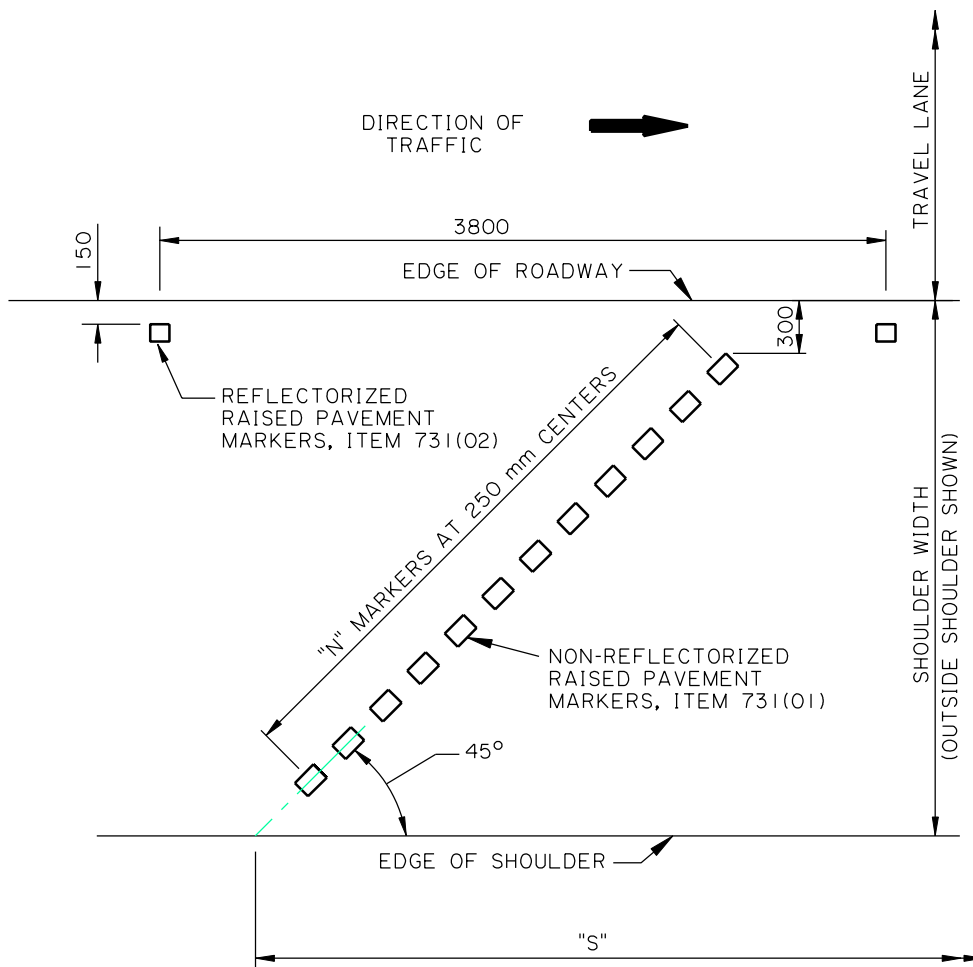
$$= [(3.6 * 0.025) + 7.2 * (0.078 - 0.025)] / 62 = (.09 + .3816) / 62 = \underline{.4716} / 62 = \underline{.007606 \text{ m/m}}$$

BRIDGE DECK DRAINAGE

1. On concrete slab span and precast-prestressed concrete girder span bridges, 150 mm diameter deck drains are typically provided along low gutter lines on 3000 mm centers. Spans directly over railroads, roadways, or embankments do not have these drains. On steel bridges, the need for drains is investigated, and when required, drains, which extend their outlet to below the low steel, are used. Design of drains such as scuppers may be found in the Bridge Deck Drainage References, November 1989, DOTD Hydraulics Section and the *Hydraulic Engineering Circular No. 21*, May 1993, Publication No. FHWA-SA-92-010.
2. Structures with significant vertical curves or which incorporate higher embankments (≥ 3000 mm above natural ground elevation) and have large deck drainage areas (≥ 250 m²) are susceptible to embankment erosion and should incorporate bridge end drains where needed.

BRIDGE DECK TRAFFIC MARKERS

1. The summary of estimated bridge quantities should include raised pavement marker items for all structures with lengths of 60 m or more.
2. The designer must check with the Road Design Section to ensure that all striping and lane separating reflectorized markers on the structure are accounted for under the roadway pay items.



* THE DIAGONAL MARKINGS ARE INTENDED FOR TWO-LANE BRIDGES AS WELL AS DIVIDED MULTI-LANE FACILITIES. SEE STANDARD PLAN PM-01-M FOR MORE DETAILS.

SHOULDER WIDTH (METERS)	NUMBER OF MARKERS PER DIAGONAL (N)
3.6	18
3.0	15
2.4	11
1.8	7
1.2	3
< 1.2	NOT REQUIRED

BRIDGE LENGTH (METERS)	REQUIRED SPACING (S) (METERS)
> 150	30
60-150	15
< 60	NOT REQUIRED

THE LAYOUT SHOWN ABOVE CANNOT BE USED WHERE THE BRIDGE WIDTH IS LESS THAN THE APPROACH WIDTH. SEE PM-01-M FOR DETAILS.

TYPICAL TRAFFIC MARKER PLACEMENT ALONG BRIDGE SHOULDER

Deck Design Details

1. Deck thickness shall vary from a minimum of **180 mm** to a maximum of **220 mm** in **20 mm** increments. Optional deck panels will not be allowed as an alternate for **180 mm** decks. Any deck thickness other than 200 and 220 mm, shall be considered a special case, and will have to be approved by the Bridge Design Engineer. Exception, lift spans generally have 165 mm deck.
2. A suggested pouring sequence for continuous spans is to be provided for spans over **25 m** in length, giving the minimum rate of pour in cubic meters per hour. The necessary information should be added to the "Miscellaneous Span and Girder Details" sheet 1 of 3. The pouring sequence is based on a 4 hour set time and attempts to minimize cracks in the top of the deck. Try to break the deck into segments at contraflexure points and pour positive moment areas first unless a continuous pour across the support is possible. See Louisiana Standard Specifications article 805.03(d) and limit rate to 45 m³ per hour.
3. Reinforcing steel shall have **50 mm** cover at the top of the slab, and **25 mm** cover at the bottom of the slab.
4. Main reinforcing bars shall be **#15, or #20** and be placed as near perpendicular to the girders as possible.
5. Longitudinal reinforcing bars shall be **#10**, unless a larger size is needed for continuity over the bents. The top plane of longitudinal steel shall have a maximum spacing of **300 mm** center to center.
6. All bars greater than **#10** will have a detailed maximum length of 18.0 m unless spliced. **#10** bars shall be limited to 12.2 m in length for handling purposes.
7. Main reinforcing steel shall have a minimum spacing of **120 mm** and not greater than the gross deck thickness plus 5 mm.
8. Interpolation of reinforcing steel in deck design table will be allowed only between two sets of identical bar size.
9. 150 mm diameter drains should not be used directly above lower travel lanes, R.R. tracks or abutment slopes, even if revetment is present.
10. Optional deck panels are restricted from use in areas with severely skewed joints (see optional deck panel sheets for geometric limits). On bridges in curves or variable width roadways, the contractor may be allowed to use panels if he provides an independent check of his design and review of all shop drawings at no additional cost.

9. The maximum spacing of tie reinforcement shall meet AASHTO 9.20.4.5 as given in the table below.

AASHTO TYPE PPCG	MAXIMUM TIE SPACING(mm)	
	#10	#15
II	600	600
III	550	600
IV	450	600
BT	210	425

$$S \leq A \times F_y \div 0.345 \times b_v$$

10. For prestressed girder projects in which the contractor elects to fabricate all the girders at the same time but girder placement will extend more than 4 months after casting (such as for phased construction or very large projects), the contractor will be required to account for camber growth. Camber for each girder shall be measured prior to erection and project engineer acceptable adjustments (such as lowering riser elevations) shall be made such that the top girder flange does not enter the bottom of the deck (maintain a positive haunch).
11. Girder Stability must be checked for transport and erection when $L / W > 35$; where L is the girder length and W is the girder flange width (see PCI Bridge Design Manual 8.10).

Applicable Standard Drawings

1. Miscellaneous Span and Girder Details (4 sheets).

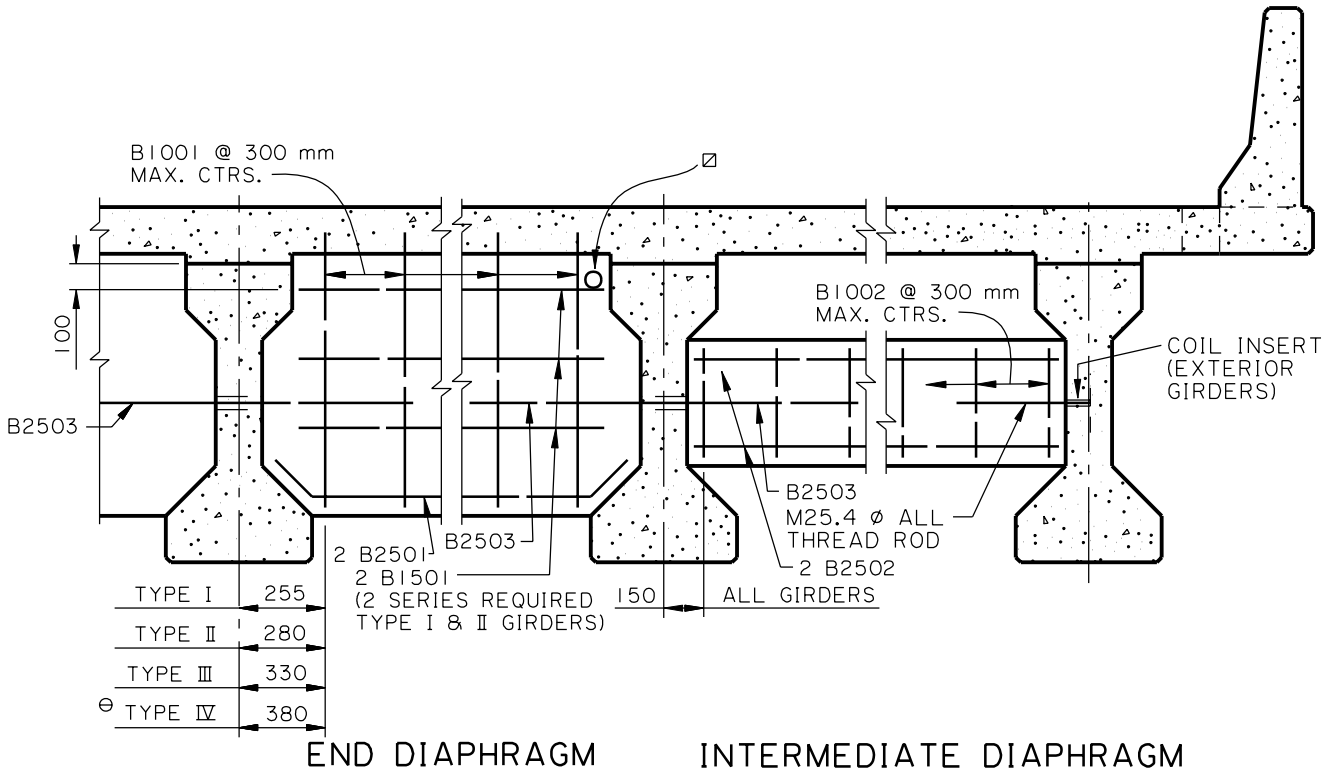
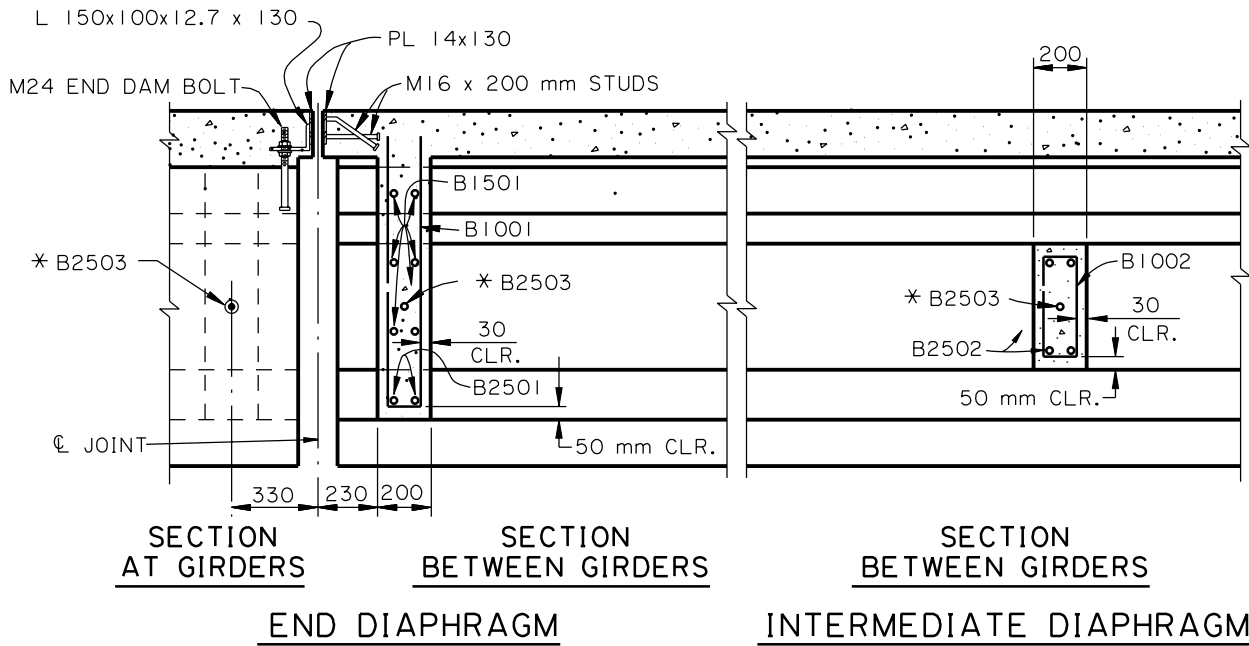
Strand Properties Table

ASTM DESIGNATION A 416 UNCOATED 7-WIRE STRANDS FOR PRESTRESSED GIRDERS								
Strand Size (Dia)	Strand Grade (MPa)	Breaking Strength (kN)	Nominal Area (mm ²)	Weight (kg/ 1000 m)	Initial Load (kN) ⊙	Load @ 1% Extension (kN)	Initial Tension (70% Breaking Strength) (kN)	Initial Tension (75% Breaking Strength) (kN)
9.5 mm	1725	89.0	51.61	405	8.9	75.6	62.3	-----
	1860 S.R.	102.3	54.84	432	8.9	87.0	71.6	-----
	1860 L.R.	102.3	54.84	432	8.9	92.1	-----	76.7
11.1 mm	1725	120.1	69.68	548	12.0	102.3	84.1	-----
	1860 S.R.	137.9	74.19	582	13.8	117.2	96.5	-----
	1860 L.R.	137.9	74.19	582	13.8	124.1	-----	103.4
12.7 mm	1725	160.1	92.90	730	16.0	136.2	112.1	-----
	1860 S.R.	183.7	98.71	775	18.4	156.1	128.6	-----
	1860 L.R.	183.7	98.71	775	18.4	165.3	-----	137.8
15.24 mm	1725	240.2	139.35	1094	24	216.2	168.1	-----
	1860 S.R.	260.7	140.00	1102	26.1	221.5	182.5	-----
	1860 L.R.	260.7	140.00	1102	26.1	234.6	-----	195.5

S.R. DENOTES STRESS-RELIEVED.
L.R. DENOTES LOW-RELAXATION.

⊙ INITIAL TENSION PRIOR TO RELEASE OF STRANDS.

* EXTERIOR GIRDERS ONLY USE
M25.4 ϕ x 965 mm ALL THREAD ROD



NOTES:

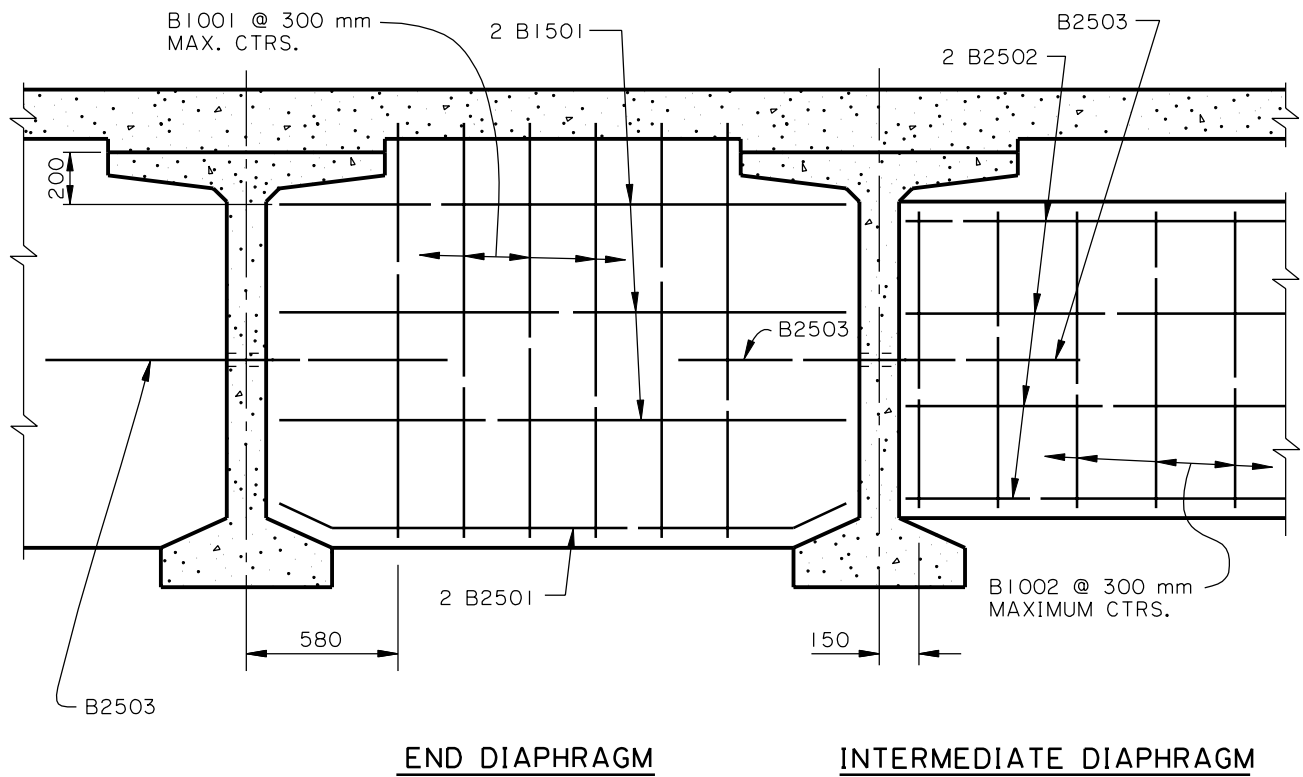
SPANS >15 m REQUIRE ONE INTERMEDIATE DIAPHRAGM.
SPANS >30 m REQUIRE TWO INTERMEDIATE DIAPHRAGMS.

Ø 75 mm ϕ VENT HOLE IN EACH END DIAPHRAGM
WHERE INUNDATION BY FLOOD IS POSSIBLE.

⊖ INCLUDES TYPE IV-MODIFIED

TYPE I-IV (END & INTERMEDIATE DIAPHRAGMS)

DIAPHRAGM DETAILS



TYPICAL DIAPHRAGM DETAILS (TYPE BT)

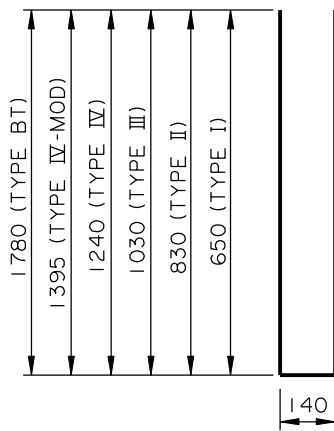
NOTE:

DETAILS NOT SHOWN ARE SIMILAR TO
DETAILS SHOWN ON SHEET 1 OF 8.

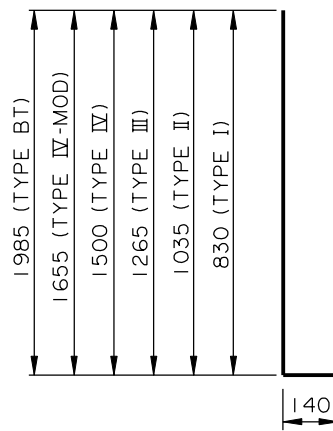
TYPE BT (END & INTERMEDIATE DIAPHRAGMS)

DIAPHRAGM DETAILS

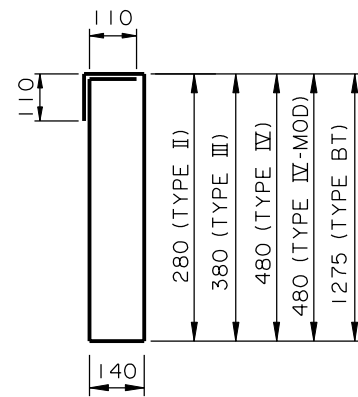
TOTAL LENGTH OF BARS						
BAR	TYPE I	TYPE II	TYPE III	TYPE IV	TYPE IV-MOD.	TYPE BT
B1001	1440	1800	2200	2620	2930	3700
B1002	N/A	1060	1260	1460	1460	3050
B1003	1800	2210	2670	3140	3450	4110
B1501	"Z"	"Z"	"Z"	"Z"	"Z"	"Y"
B2501	"X"+220	"X"+280	"X"+380	"X"+500	"X"+500	"X"+440
B2502	"Y"	"Y"	"Y"	"Y"	"Y"	"Y"
B2503	1980	1980	1980	1980	1980	1980



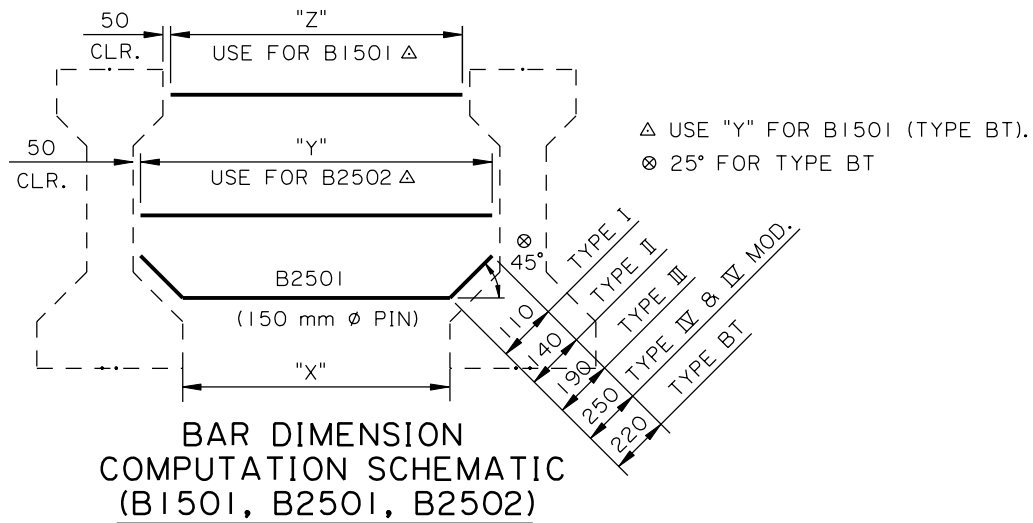
B1001
(45 mm Ø PIN)



B1003
(45 mm Ø PIN)

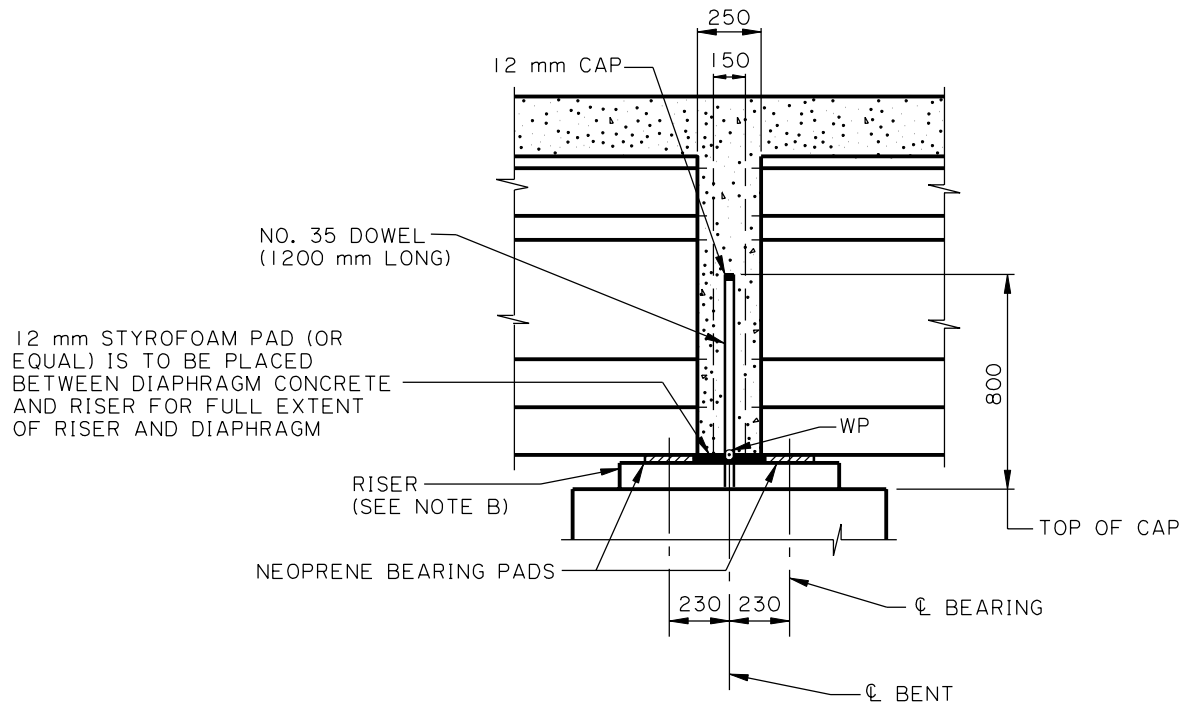


B1002
(45 mm Ø PIN)



TYPE I-IV AND BT (REINFORCING STEEL)

DIAPHRAGM DETAILS



CONNECTION DETAIL AT CONTINUITY DIAPHRAGM

NOTE A

DOWELS IN THE CAP SHALL BE GALVANIZED NO. 35 DEFORMED REINFORCING STEEL. PRIOR TO POURING THE CONTINUITY DIAPHRAGM, EACH DOWEL SHALL BE SHEATHED BY 45 mm I.D. RIGID SLEEVE WITH A 12 mm THICK COMPRESSIBLE CAP ABOVE THE TOP OF THE DOWEL TO ALLOW THE GIRDERS TO DEFLECT ON THEIR BEARING PADS UNDER FUTURE LOADS.

TO FACILITATE PLACEMENT OF GIRDERS, THE CONTRACTOR MAY SET THE NO. 35 DOWELS BY ONE OF THE FOLLOWING METHODS:

- 1) SETTING DOWELS IN APPROVED NON-SHRINK GROUT IN PREFORMED HOLES HAVING A MINIMUM DIAMETER OF 75 mm.
- 2) SETTING DOWELS AT INITIAL CASTING OF CAP.

NOTE B

RISERS AT FIXED BENTS SHALL BE SLOPED TO APPROXIMATE TANGENT GRADE AT CL BENT. ELEVATIONS SHOWN FOR THESE RISERS ARE AT CL BENT.

CONNECTION DETAIL AT CONTINUITY DIAPHRAGM

DIAPHRAGM DETAILS

9. The curb and railing dead load will be placed on the composite section of the exterior girder only.
10. The steel section of exterior girders shall have at least the same structural capacity as the interior girders for future widening purposes.
11. For the design of friction type connections surface condition "A", (clean mill scale) will be assumed.
12. Structural steel may be A 709 Grades 250, 345 or 345W. Gusset plates, stiffeners, bracing and other secondary members are generally designed using Grade 250.
13. Utilize plastic design when allowed.

DETAILING

1. The haunch shall be set so there is no encroachment by cover splice plates and their connectors into the deck.
2. Cantilevered deck slabs shall have their bottom surface aligned with the bottom of the girder flange.
3. The flange widths shall preferably be specified in multiples of **50 mm**. Flange thickness will be specified in multiples of **5 mm** for $t < 60 \text{ mm}$ and **10 mm** multiples for $t \geq 60 \text{ mm}$.
4. The web plate heights shall be specified in multiples of **50 mm**. Web thickness will be designed as follows:

$$\begin{array}{ll} 10 \text{ mm} \leq t \leq 22 \text{ mm} & 2 \text{ mm increments from } 10 \text{ mm} \\ t > 22 \text{ mm} & 5 \text{ mm increments from } 25 \text{ mm} \end{array}$$

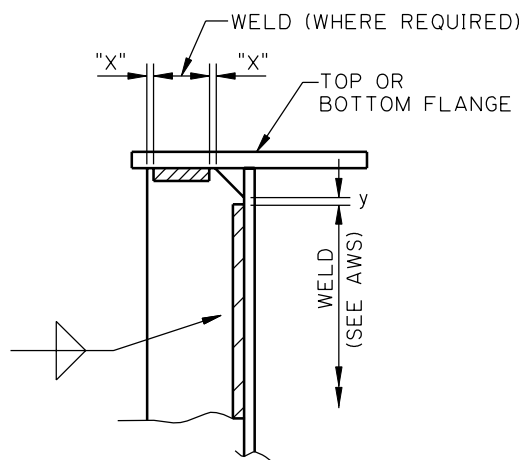
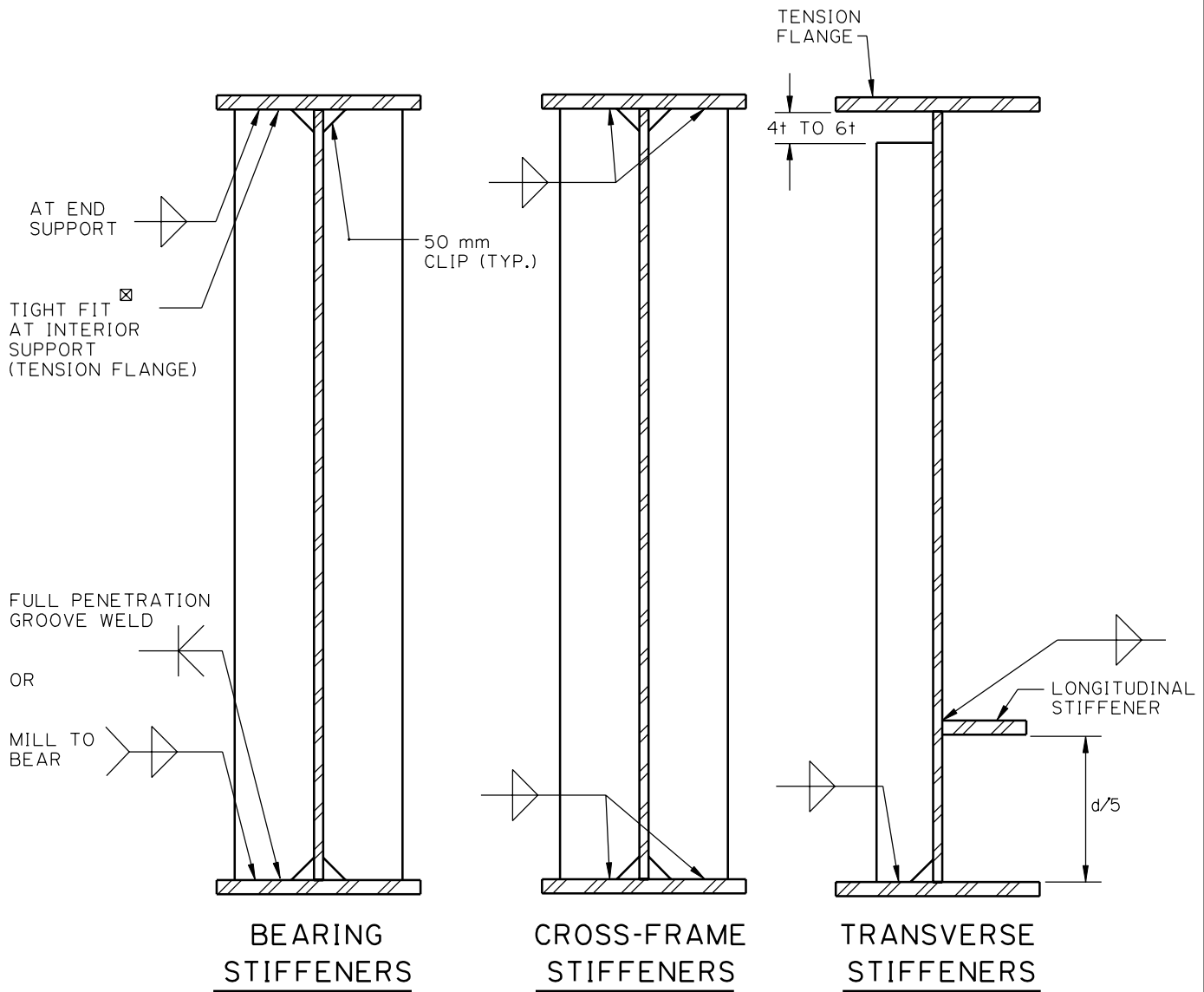
5. The location of "permissible welded shop splices" in girder web and flange plates shall be shown on the girder sheets. Generally, the limit of plate lengths without splices is **15 m**.
6. Full penetration groove welded connections at transitions in thickness or in width shall have slopes no steeper than 1 to 5.
7. When applicable, the following note shall be added to the plans:

THE CONTRACTOR MAY PROPOSE ALTERNATE SPLICE LOCATIONS FROM THOSE SHOWN IN THE PLANS, OR BOLTED FIELD SPLICES IN LIEU OF WELDED SPLICES, ALL AT NO ADDITIONAL COST TO THE DEPARTMENT AND SUBJECT TO THE APPROVAL OF THE ENGINEER PRIOR TO INCLUSION IN THE SHOP DRAWINGS.

31. Swing Spans are not considered to be fracture critical by the bridge design section. Load case II for swing spans shall use temperature difference between top and bottom chords of **15°C** and a short span uplift equal to **25 mm**. *Dead load plus impact* shall be added to case II worst wedge reaction for total case II design loads.
32. All bolting for structural steel bridge members shall utilize Direct Tension Indicator (DTI) washers during installation. When DTI s are used, the bolts are tightened until the bolt tension collapses the washer protrusions to the specified 127 µm. gap. This will ensure proper bolt tension. Inspection is accomplished by means of a 127 µm feeler gage inserted to the washer gap. |

The DTIs will always be galvanized with the additional requirement that for use on unpainted weathering steel, DTI shall be epoxy coated to prevent accelerated sacrificial galvanized coating loss.

33. For simple span steel girder designs, dead load camber shall be increased by a factor of 15% to account for observed camber loss due to dissipation of residual stresses. |



TYPICAL WELDING DETAIL

"X" = 6 mm ± 3 mm
 "y" = 12 mm ± 6 mm

☒ ADD FILLET WELD WHEN BEARING STIFFENERS ARE USED AS CROSS-FRAME STIFFENERS. PROPER FATIGUE CATEGORY SHALL BE USED.

TYPICAL SECTIONS THRU GIRDER

STIFFENERS

PAD		PLAIN	REINFORCED	REFERENCE
VARIABLE				
HARDNESS		70	60	SHORE “A”
$F_c TL (N/mm^2)$		10.8×10^{-6}	1.38	14.4.1.1
G	Gc	1.38	0.90	T 14.3.1
	Gs	2.07	1.38	T 14.3.1
B		1.8	1.4 outer	14.2
		1.8	1.8 inner	14.2
CREEP		45%	35%	T 14.3.1

Design (Method A)

- $$W \approx b_f =$$
- $$TL = (P_{dl} + P_{ll}) =$$
- $$L \geq TL \div (F_{cTL} \times W) =$$
- $$\sigma_c = TL \div (L + W) =$$
- $$h_{ri} \leq G_c \times (L \times W) \div [2 \times \sigma_c \times (L + W) \times \beta] = \text{compression}$$

14.4.1.1

$$h_s = 1.6 \text{ mm}$$

$$F_y = 227.5 \text{ N/mm}^2$$

Std Spec 1018.14(a)
 - $$F_{all} = 0.55 F_y$$

T10.32.1A
 - $$\leq 165 \text{ N/mm}^2$$

T10.3.1A, 2 million cycles
 - $$2) h_{ri} \leq (F_{all} \times h_s) \div (1700 \times 4.448 / 25.4) = \text{shim strength}$$

14.4.1.6
 - $$\leq 16.9 \text{ mm}$$
 - $$\Delta h = [\alpha(\Delta T) + \text{Shrink}] \times l = \text{DOTD \& FHWA use}$$

total ΔT

7. $\Delta s \approx _h$ = Δh modified for pier flex. |
8. n = No. of inner layers =
- 3) $h_{ri} \geq (2 \times _s) \div (n + 2/1.4)$ = shear 14.4.1.3

4) select h_{ri} and n to satisfy equation 1,2,& 3

$$h_{ri} =$$

$$n =$$

$$\text{select } h_{ro} \approx h_{ri}/1.4 =$$

$$\text{check stress: } h_{crit}/\beta \geq h_{ri}/1.0 \geq h_{ro}/1.4 =$$

$$S/\beta = (W \times L) \div [2(W + L)(h_{crit}/\beta)] =$$

$$\sigma_c < G_c(S/\beta) =$$

$$5) h_{rt} = n \times h_{ri} + 2 \times h_{ro} =$$

$$h = h_{rt} + (n+1) \times h_s =$$

$$\leq L/5 \text{ (plain)} =$$

$$\leq L/3 \text{ (reinforced)} =$$

stability check 14.4.1.5

$$6) H = G_s(L \times W)(\Delta s/2) \div h_{rt} \\ \leq 0.2P_{dl}$$

slip check 14.6.1
(if no slip apparatus is used) |

$$7) \epsilon_{ci}^{TL} = f(S/\beta, \sigma_c) = \text{See figure F14.4.1.2B or}$$

$$= \left[\frac{\sigma_c}{2.3 \left(\frac{S}{\beta} \right)^{1.63}} \right]^{\left(\frac{I}{1.15 + 0.0286 \left(\frac{S}{\beta} \right)} \right)}$$

International Bridge Conference 88-17 Eq 37

$$\leq 0.07 \text{ FHWA Region 3 SCEF Comm.10}$$

$$\Delta_c^{TL} = n \times h_{ri} \times \epsilon_{ci}^{TL} + 2 \times h_{ro} \times \epsilon_{co}^{TL} \\ \leq ? \text{ mm agency instantaneous deflection limit}$$

$$\Delta_c^{DL} = n \times h_{ri} \times \epsilon_{ci}^{DL} + 2 \times h_{ro} \times \epsilon_{co}^{DL} (1 + \text{creep}) \quad (\text{agency long term deflection limit}) \\ \leq 3 \text{ mm}$$

GD = grade difference between riser and bottom of girder

$$1. \quad \theta^{TL} = (\theta^{DL} + \theta^{LL}) \approx w_{DL}L^3/24EI + 1/400 \pm GD$$

CORROSION PROTECTION METHODS

GENERAL

Details given in Chapter V provide adequate corrosion protection for the average application. For those locations where severe corrosion potential exists (exposure to coastal splash zones, deicing chemicals, areas where there is a history of corrosion problems), the Bridge Design Engineer will determine the method to protect the concrete reinforcing steel, including direct treatments (galvanizing or epoxy coatings), corrosion inhibitors (calcium nitrite), and silica fume or fly ash for reducing concrete permeability.

Fly ash

A pozzolan is a by-product of pulverized coal-fired electric power generation. It is physically smaller than the average cement particle and is round.

PROS:

- 1) Improves workability (pumping and ease of flat-work finishing) of fresh concrete
- 2) Reduces peak temperature of mass concrete
- 3) Long term reaction products help fill in spaces between hydrated cement particles, thus lowering permeability to water and aggressive chemicals
- 4) Reduces required water in mix for given slump
- 5) Increases long-term strength of concrete if moist environment and moderate temperatures maintained
- 6) Low cost
- 7) Allows reduction in cement content

CONS:

- 1) Reduced early strength, increases setting time (both initial and final)
- 2) Decreases entrained air
- 3) Class C can cause corrosion (use Type F)

Column Bents come in a variety of configurations. The most common is the two-column bent with round columns, normally used on two lane bridges.

Hammerhead column bents are often used on ramp structures. For bridges with column heights greater than 15 m, tapered columns are often used for greater economy.

Inverted T-caps are sometimes used for aesthetics, but primarily, where vertical clearance dictates their need. Inverted T-caps should be used only with approval of the Bridge Design Engineer.

RIVER PIERS AND COFFERDAMS

Where bridges cross major stream or river crossings and pile bents are not feasible, the use of a column bent constructed with a cofferdam is most commonly used. For major Mississippi River Bridge crossings, caissons are commonly used. As an alternate, large diameter drilled shafts should be investigated when deemed appropriate for the site.

All bridge crossings subject to navigational traffic should be investigated for the appropriate protection system due to vessel impact. This may include placing the piers out of the channel when it is feasible, designing the piers for vessel impact, or placing protection systems such as fenders and/or dolphin islands around the piers. The AASHTO "Guide Specification and Commentary for Vessel Collision Design for Highway Bridges" should be referred to for more information.

PERMANENT OR TEMPORARY SHEET PILE WALLS

Steel sheet pile walls are commonly used for both permanent and temporary applications. For sites where a permanent bulkhead is needed such as a navigational waterway, permanent sheet pile walls are often used. They are commonly designed either as a cantilever or tied back wall.

The departmental policy on sheet pile walls is as follows:

1. Permanent Sheet piling: Where required by the plans, permanent sheet piling shall be of the design shown in the contract plans. Sheet piling shall be new and shall receive corrosion protection as specified in accordance with the Standard Specifications. Payment shall be as per Section 803 of the Standard Specifications.
2. Temporary Sheet piling: Temporary Sheet piling for excavations shall be in accordance with Section 802 of the Standard Specifications. The contractor will be responsible for the design and details of the sheet piling. There will be no direct payment for sheet piling unless a pay item for cofferdams is included in the plans. Sheet piling may be new or used, does not require corrosion protection and will be removed when no longer required.

3. Construction Sheeting: Where contract plans require sheeting to facilitate the sequence of construction and to support traffic carrying facilities, the contract plans shall specify the required design for sheeting. Sheeting may be new or used and will not require corrosion protection. Typically, construction sheeting will be removed when no longer required; however when impractical to remove or when required in the plans, sheeting may remain in place in the completed work. Payment for construction sheeting shall be by "S" item, Lump Sum.

DRIVEN PILES

INTRODUCTION

The most commonly used driven pile types are precast-prestressed concrete, cast-in-place concrete, steel "H", steel pipe and timber. This section is a guide to methods of pile foundation design and details.

It is conceded that the problem of foundation analysis is a highly complex one and that sometimes experience and intuition will be the better part of analysis. In this light, if any analysis and soil boring interpretation is followed blindly, serious errors in estimating foundation capacities can result.

The bridge designer normally proposes the type and length of pile foundation during preliminary plans. The Geotechnical and Construction sections should be consulted both during preliminary and final design to review and make comments on the proposed pile lengths, pile type and field-testing.

PILE DESIGN

Soil borings are required on all bridge projects for which piling is involved. In cases where an existing bridge will be widened or replaced on an existing alignment, the engineer should evaluate the following information first from the existing bridge records.

- a) Existing bridge borings.
- b) Existing test pile reports.
- c) Existing pile driving records.

On projects for which all or some of the above information is available and contains sufficient information for the design of the foundation, there will be no need to order new borings.

Should the existing information not be sufficient or is not available, new borings must be ordered. New borings must be ordered through our Geotechnical Section. Information on

how to order new borings and a boring request form can be found in chapter 1 or you may contact the Geotechnical Section. Any existing deep boring data should be attached to the boring request. The date when the complete geotechnical data (borings, consolidation and settlement analysis) are needed, should be included in the request. In the absence of this information, priority will be established by the preliminary plan date.

Piles shall be designed using service loads excluding live load impact. The maximum pile loads (design load) should always be shown on the construction drawings, normally with bent details or on the pile data sheet. Piles can be designed as friction piles, bearing piles, or a combination of both. The weight of the pile is normally neglected except in special cases involving large diameter piles and when cofferdams and tremie seals are used. The pile lengths for both on-system and off-system bridges are determined using the appropriate safety factors which are selected based on field-testing, type and amount of soils data and geotechnical analysis, type of project, static and dynamic load test and method of modeling pile installation. See Field Testing for more information on safety factors.

In order to set the plan pile lengths, a static analysis to determine ultimate pile capacity is normally performed on each boring for friction and bearing capacity. Due to the variety of soil conditions, this manual will not attempt to describe the analysis procedures. The engineer should confer with the Geotechnical Section when performing a static analysis. The design engineer will normally use the total soil shear strengths determined from either unconfined compression tests or standard penetration tests to determine the pile friction and end bearing for various piles and loads. If economically feasible, the engineer should attempt to tip end bearing piles in very dense sands ($n > 50$ blows). The end bearing piles should penetrate a minimum of 1.5 m into the 50 blow count material.

The plan pile lengths are established when the design event ultimate pile capacity divided by the required factor of safety is equal to or greater than the design load.

Pile sizes should be proportioned so that the following criteria are met.

- a) As a general rule, the maximum slenderness ratio of $L/d \leq 20$ should be maintained.

L = pile unsupported length (mm). The unsupported length is measured down below the channel bottom or ground line accounting for estimated scour, if appropriate (1.5 m minimum), plus a distance to the assumed point of pile fixity. In general, pile fixity can be assumed at 1.5 m below scour line or ground line. See figure on page 25.

d = the least dimension or diameter of the pile section (mm).

The maximum unsupported pile lengths based on a $L/d = 20$ are as follows:

The following typical splices are approved to be used on precast concrete and steel piles.

Pile Type	Pile Size (mm)	Pile Splice Type
Precast Concrete	350, 750	Cement dowel
Precast Concrete,	350,400,450	Dyna-a-splice (proprietary)
Precast Concrete,	600	ABB (proprietary)
Steel	All sizes	Full penetration butt weld

Standard details are available for the precast concrete pile splices, except for ABB splices.

- g) For piles with a diameter less than 0.6 m, an 6.10 m minimum pile penetration should be provided for stream crossings below the estimated scour elevation.
- h) For pile diameters equal to or greater than 0.6 m, a 7.62 m minimum pile penetration should be provided for stream crossings below the estimated scour elevation.

Battering piles is an expensive process and should be specified only when necessary. The exterior pile in bents should be battered when the unsupported pile length is excessive. Battering footing piles provides the necessary lateral support that is sometimes required to resist excessive lateral loads transferred from the column to the footing. This is particularly true for short column bents due to cap shrinkage. Maximum batter is usually 1 on 4 for footing piles and 1 on 8 on pile bents.

The allowable strength of precast concrete piles is seldom, if ever, exceeded by the design loads. Pile handling and transportation govern the design, thus establishing the maximum casting length and pick up point locations.

Cast-in-place concrete piles are used primarily in south Louisiana and are designed either as friction piles or combination friction and bearing piles. When cast-in-place piles are included as an alternate for precast piles, the pile lengths should be set based on the cast in-place pile, and only precast piles will be allowed in the end bents.

When hard driving is anticipated, particularly where jetting is not desirable, such as footing piles, the designer should consider non-displacement piles such as open-ended pipe or H piles. The designer should discuss this with the Geotechnical section.

The pile group capacity will be considered in foundation analysis if the center to center spacing is less than three pile diameters. Under normal situations, this is not allowed.

The consolidation settlement shall be computed for all pile groups. The pile group settlement shall be the same as shown for drilled shafts on page 19.

All timber piles for permanent structures shall be treated timber according to the Standard Construction Specification. Coastal treatment should be considered for use at locations south of I-10/I-12 line. Where coastal treatment is used, it should be clearly specified in the plans. Temporary structures such as detour bridges shall use treated timber piles.

PILE DETAILS

1. The following pile standard details are available and shall be included in the plans when applicable.

Standard Detail	Description
CS - 216(M)	Precast-Prestressed Piles
Concrete Pile Alternates	Cast-in-place Concrete Piles
Pile Splice Details	Cement Dowel, Dyna-a-Splice

2. Steel pipe piles shall generally be driven with open ends only.
3. Pile lengths should normally be shown on the general bridge plan. Pile tips, cutoff elevations, pile lengths and design loads should be shown on a pile data table.
4. For moderate to complex projects involving skews, horizontal curves, interchanges, etc., or where interaction with existing foundations is present, the plans should include a foundation layout. The layout must show bents and/or footing pile locations and referenced to the centerline or P.G.L. Existing structures or substructures that may conflict with the pile driving must be clearly shown. Boring locations as well as test piles, CPT probings, PDA monitor piles and indicator piles must also be shown.

- a) CPT PROBINGS: CONE PENETROMETER TEST (CPT) PROBINGS WILL BE REQUIRED AT THE LOCATIONS NOTED IN THE GENERAL PLANS OR FOUNDATION LAYOUT AND AT TEST PILE AND INDICATOR PILE LOCATIONS. CPT PROBINGS WILL BE PERFORMED BY THE DEPARTMENT IN ACCORDANCE WITH SECTION 804 OF THE SPECIFICATIONS.
- b) CPT PROBINGS: CONE PENETROMETER TEST (CPT) PROBINGS WILL BE REQUIRED AT THE LOCATIONS NOTED IN THE GENERAL PLANS OR FOUNDATION LAYOUT AND AT TEST PILE AND INDICATOR PILE LOCATIONS. CPT PROBINGS WILL BE PERFORMED BY THE CONTRACTOR.

When the CPT probings are performed by the contractor, (note b), the maximum CPT penetration elevation should be specified in the plans as follows:

- a) THE MAXIMUM CPT PROBING PENETRATION ELEVATION FOR ALL CPT PROBINGS SHALL BE ____ (*elevation in meters*).
- b) THE MAXIMUM CPT PROBING PENETRATION ELEVATION SHALL BE ____ (*elevation in meters*). FOR CPT PROBINGS TAKEN AT BENTS (##) THROUGH (##).
- c) THE MAXIMUM CPT PROBING PENETRATION ELEVATION FOR TEST PILE (##) SHALL BE ____ (*elevation in meters*).

Pile Driving Analyzer, (PDA)

PDA may be used to monitor the pile driving installation of Test Piles, Indicator Piles, and Monitor Piles. A note similar to the following note should be placed in the **General Notes of the bridge plans**. It should be modified as needed.

DYNAMIC MONITORING: THE PILE DRIVING ANALYZER (PDA) WILL BE REQUIRED AT EACH TEST PILE, INDICATOR PILE, AND MONITOR PILE OR AS DIRECTED BY THE ENGINEER.

When Dynamic Monitoring is required use the appropriate item number from section 804 and include an S-item for Dynamic Analysis.

Indicator Piles

Indicator Piles may be used to determine the final pile order lengths. In this case, an Indicator Pile is driven in advance of the production piles. The difference between Indicator Piles and a standard test pile is that loading Indicator Piles is not anticipated. Indicator piles should be cast long enough to be redriven, if necessary, to the plan tip elevation of the piles at the nearest bent or as determined necessary by the CPT probing. Indicator Piles are usually piles tipped on marginal end bearing soils. The Indicator Pile is used to access pile driveability problems such as hard driving which may require jetting or predrilling and to assess the bearing capacity of marginal bearing soil. The Indicator Pile driving installation is monitored with the PDA to evaluate the pile driving equipment

performance and to monitor the pile driving stresses. Pile bearing capacity and driving criteria will be developed from data obtained from the PDA monitoring. The location of these piles is generally based on the type and size of pile to be driven and the anticipated subsoil profile at each bridge structure. The indicator pile is paid for as a modified test pile (i.e. Item 804(05)(A) Precast Concrete Test Pile (Indicator Pile)). Pay items for each type of indicator pile used should be shown in the plans.

Redriving of indicator piles is paid for under Item 804(11), Redriving Test Piles. If it is determined from the driving records and PDA monitoring that the indicator pile should be load tested, each load test shall be paid for under Item 804(09)(A).

The following note should be placed in the **General Notes of the bridge plans**.

INDICATOR PILE: INDICATOR PILES WILL BE REQUIRED AT THE LOCATIONS SHOWN ON THE GENERAL PLANS OR FOUNDATION LAYOUT.

Monitor Piles

A Monitor Pile may be used to monitor the pile driving installation with the PDA. This is usually accomplished by monitoring the first permanent pile of its type and size to be driven at each bridge structure or at a specified bent location. The location of these Monitor Piles is generally based on the type and size of pile to be driven and the anticipated subsoil profile at each bridge structure. The PDA is used to evaluate the pile driving equipment and to monitor the pile driving stresses. Pile driving criteria will be developed from this information. The Monitor Pile is paid for as a permanent pile. The dynamic monitoring is paid for with the Dynamic Monitoring item and the Dynamic Analysis S-item. One of the following notes should be placed in the **General Notes of the bridge plans** depending on where the indicator pile(s) is located.

- a) MONITOR PILES: THE FIRST (*size, type*) PILE DRIVEN AT EACH BRIDGE SHALL BE MONITORED WITH THE PILE DRIVING ANALYZER (PDA).
- b) MONITOR PILES: THE FIRST (*size, type*) PILE DRIVEN AT BENT NO. (##) SHALL BE MONITORED WITH THE PILE DRIVING ANALYZER (PDA).
- c) MONITOR PILES: THE FIRST (*size, type*) PILE DRIVEN AT BENTS (##) THROUGH (##) SHALL BE MONITORED WITH THE PILE DRIVING ANALYZER (PDA).

Permanent Piles

Permanent Piles are those piles that are furnished by the contractor in accordance with an approved order list for use in production driving of foundation piles for the final substructure. If the driving resistance of a permanent pile should not correlate with the test pile or be less than that of the test pile, the engineer may require a static load test among other courses of action.

The following plan note should be placed in the **General Notes of the bridge plans**.

PILES: ALL PILE REQUIREMENTS INCLUDING SIZE, TYPE AND MAXIMUM DESIGN LOAD AND TEST PILE REQUIREMENTS AS TO LOCATION AND TEST LOADING SHALL BE AS DESCRIBED ON THE PLANS OR IN THE SPECIFICATIONS. SEE STANDARD DETAIL CS 216(M). THE MINIMUM PILE TIP ELEVATIONS WILL BE PLAN PILE TIP ELEVATIONS UNLESS NOTED ON THE PLANS OR OTHERWISE AS DIRECTED BY THE ENGINEER.

In addition, one of the following pile length notes shall be included as needed in the PILES: note in the plans.

- a) PILE LENGTHS SHOWN IN THE PLANS ARE ORDER LENGTH PILES.
- b) PILE ORDER LENGTHS WILL BE PROVIDED AFTER COMPLETION OF THE CPT PROBINGS AND/OR TEST PILE LOAD TESTING AND/OR INDICATOR PILE INSTALLATION AND EVALUATION AS REQUIRED BY THE PLANS.

Jetting

When appropriate, jetting may be used to facilitate pile installation. This practice shall be predominately used when hard driving is anticipated during pile installation of end bearing piles. Jetting should not be allowed for friction piles, piles in footing, header banks or where stability of embankment or other improvements may be endangered. When jetting is allowed or required, the following note shall be added to the Special Provisions

JETTING: JETTING MAY BE REQUIRED IN ACCORDANCE WITH SECTION 804.08(B) AT (list of the locations).

The note above amends the Standard Specifications sub section 804.08(B), Water Jets.

For more specific information on this subject as well as appropriate plans and specifications requirements including pay items, refer to the latest DOTD's Standard Specifications.

Types of Field Load Testing

1. **Static Load Test:** This work consists of applying static loads at predetermined intervals to Test Piles and in some cases to Indicator Piles or Permanent Piles. The static loads are applied in increments of 10 to 15 percent of the design load and held for an interval of 5 minutes. The loads are increased until pile failure occurs or three times the design load is reached. The ultimate pile capacity is determined through the analysis of the load settlement curve then a safety factor of 2.0 is applied to determine adequacy of pile tip elevation. Test piles will be loaded unless otherwise directed by the engineer. Test piles shall remain undisturbed for at least 14 calendar days after driving, unless otherwise directed by the engineer, to required penetration before beginning loading operations.
2. **Dynamic Monitoring:** This work consists of assisting the Department in obtaining dynamic measurements with the Department's Pile Driving Analyzer (PDA) of test piles, indicator piles, and permanent piles during initial pile driving and during pile restrikes. The cost of equipment mobilization or any delays due to dynamic monitoring shall be at no direct pay. To allow space for attachment of instrumentation when dynamic monitoring is specified on test piles, indicator piles, and monitor pile, the piles shall be long enough to allow access to the top 2.5 pile diameters or side dimension of the pile at the end-of-driving penetration. The dynamic monitoring shall be performed for the purpose of obtaining the ultimate pile capacity, pile driving stresses, pile integrity, and pile driving system efficiency.

Types Of Pile Capacities

1. **Static Load Test Capacity:** This is the computed ultimate pile resistance that we are anticipating during the static load testing of a test pile, indicator pile, or permanent pile. The soil resistance will depend on the as-driven conditions such as overburden of the scour zone, scour zone soil resistance if it has not been cased or excavated, etc. The reaction system shall be sized to resist three times this estimated Static Load Test Capacity shown in the plans or as directed by the engineer.
2. **Ultimate Pile Capacity:** This is the ultimate pile capacity that has been determined from either a static or dynamic test of a test pile, indicator pile, or permanent pile.
3. **Design Load:** Is the maximum computed working load that the pile foundation is anticipated to support during the life to the structure.
4. **Design Event Ultimate Pile Capacity:** This is the computed static ultimate pile resistance that should be available after neglecting the scour zone and accounting

DESIGN

1. All projects involving drilled shafts will be approved prior to design, by the Bridge Design Engineer Administrator.
2. As a general rule, size the drilled shaft for a compressive stress of **3 MPa** across the cross section of the shaft. However, the soil characteristics and the design requirements for the shaft to sustain both axial and lateral loads will determine the final size and length of the required shaft.
3. Side friction will be utilized, i.e., the shafts will be constructed with the casing extracted, unless otherwise approved by the Bridge Design Engineer Administrator.
4. For drilled shaft design, Class S concrete will be used and the concrete compressive strength will normally be limited to $f'_c = 18 \text{ MPa}$.
5. All drilled shafts, where the concrete or slurry is placed under water, will be constructed with access tubes to allow for cross-hole sonic logging, CSL. The test will determine if anomalies are present in the shaft, which may reduce its capacity. If the shaft has a reduced capacity the payment and/or rejection will be based on the CSL testing. The acceptance or rejection of the shaft will be based upon CSL test results and the analysis by the Geotechnical Design Unit.
6. Drilled shafts used in abutments shall have a minimum diameter of 600 mm, however, a diameter of 750 mm is preferable.
7. A minimum reinforcement of 1% of the gross shaft area shall be extended to the bottom of the shaft.
8. Drilled shafts are available in 150 mm increments from 450 mm to 3600 mm. Some shafts may be available in the 4800 mm range.
9. Drilled shafts should be spaced center to center a minimum of three (3) times the shaft diameter, however, shafts can be placed closer if group capacity is accounted for in the foundation analysis.
10. Battered drilled shafts will not generally used.
11. Belled footings will not be used.
12. Detailed clearances for the reinforcement to the outside of the drilled shaft will be 75 mm for shafts with a diameter of 750 mm or less and 150 mm for shafts greater than 750 mm.

For further design information consult the Pavement and Geotechnical Design Section and AASHTO.

5. Double stirrups shall be used in all pile bent caps exceeding 750 mm in width.
6. Stirrups shall be spaced at a maximum of 300 mm. The stirrups adjacent to piles shall be located at a maximum of 75 mm from the face of the pile and the first space shall be a maximum of 150 mm. The size of stirrups shall be a minimum of No. 10 bars.
7. The centerline at the top of the exterior pile shall not exceed more than 460 mm beyond the centerline of the exterior girder.
8. The pile bent design should account for two (2) adjacent piles each being mislocated a maximum of 150 mm in the direction parallel to the cap.
9. Pile bent caps shall have a minimum depth of 600 mm for all slab span supporting bents and all single row pile bents with less than 600 mm piles and 700 mm for all single row pile bents with 600 mm piles or larger. Double row pile bents shall have a minimum cap depth of 750 mm.
10. The minimum longitudinal cap steel shall be in accordance with the AASHTO Specifications.
11. As a general rule, $\frac{L}{d}$ in pile bents should not be over 20. See further discussion under driven piles.
12. The top and bottom reinforcement in caps shall be the same.
13. The concrete quantity for the pile cap shall not include the volume of concrete displaced by the pile embedment.
14. Spacing for double row pile bents shall be determined on an individual basis.

3. Wingwalls, breast walls and the bent as a unit shall be designed to resist active earth pressure under the appropriate group loads.
4. The reaction of the approach slab to the shelf of the end bent is based on the same assumption as in Items 1 and 2.

DESIGN DETAILS

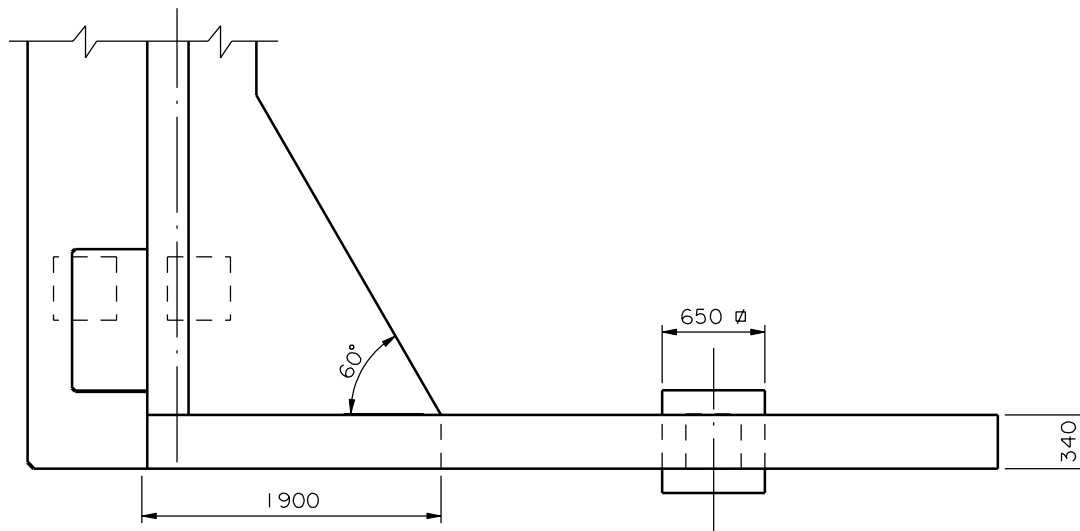
1. Wingwalls with stabilizing piles are required for all end bents on fills with the exception of slab span bridges and concrete girder spans with Type II girders.
2. Double-row, battered piles are required on all end bents except those for slab spans. Pile batter shall be 1 on 8.
3. On double row pile end bent caps, a 300 mm thick baffle shall extend 600 mm below the cap between rows of piling to prevent the movement of the soil confined by the bent.
4. On skewed or normal end bents, the roadway end of the approach slab is to be squared off for both rigid and flexible pavements.
5. Slab span end bents should be designed as interior bents.
6. Negative skin friction, caused by the consolidation of the fill and in situ soil in contact with the piles, is assumed to be insignificant because pilot holes are used for piling driven through a compacted fill. Granular material is used to fill the void between the pilot hole and the pile.
7. Pile supported approach slabs are continuous slabs supported by rows of timber piles on 3 m centers. The spacing between the piles along the cap is between two (2) and three (3) meters. The timber piling shall be varied in length from row to row by a constant amount. Piling shall penetrate the footing to resist the tension required to hold the slab in its deformed configuration after settlement has occurred. Pile supported slabs are designed as one way slabs spanning between transverse grade beams at the pile rows.
8. When pile supported approach slabs are used, the barrier rail shall be extended the full length of the approach slab. This will prevent potential guardrail problems caused by embankment settlement in the deep pile region of the approach slab.
9. Prestressed girders end bent caps shall have a depth of 750 mm .
10. In south Louisiana, sand embankments are terminated by a shell plug, which eliminates erosion, formation of cavities, and settlement problems related to sand

embankments and sand header banks. In north Louisiana, where shell is not readily available, sand embankments are to be terminated by a clay plug at structure header banks in the same manner a shell plug is used in south Louisiana.

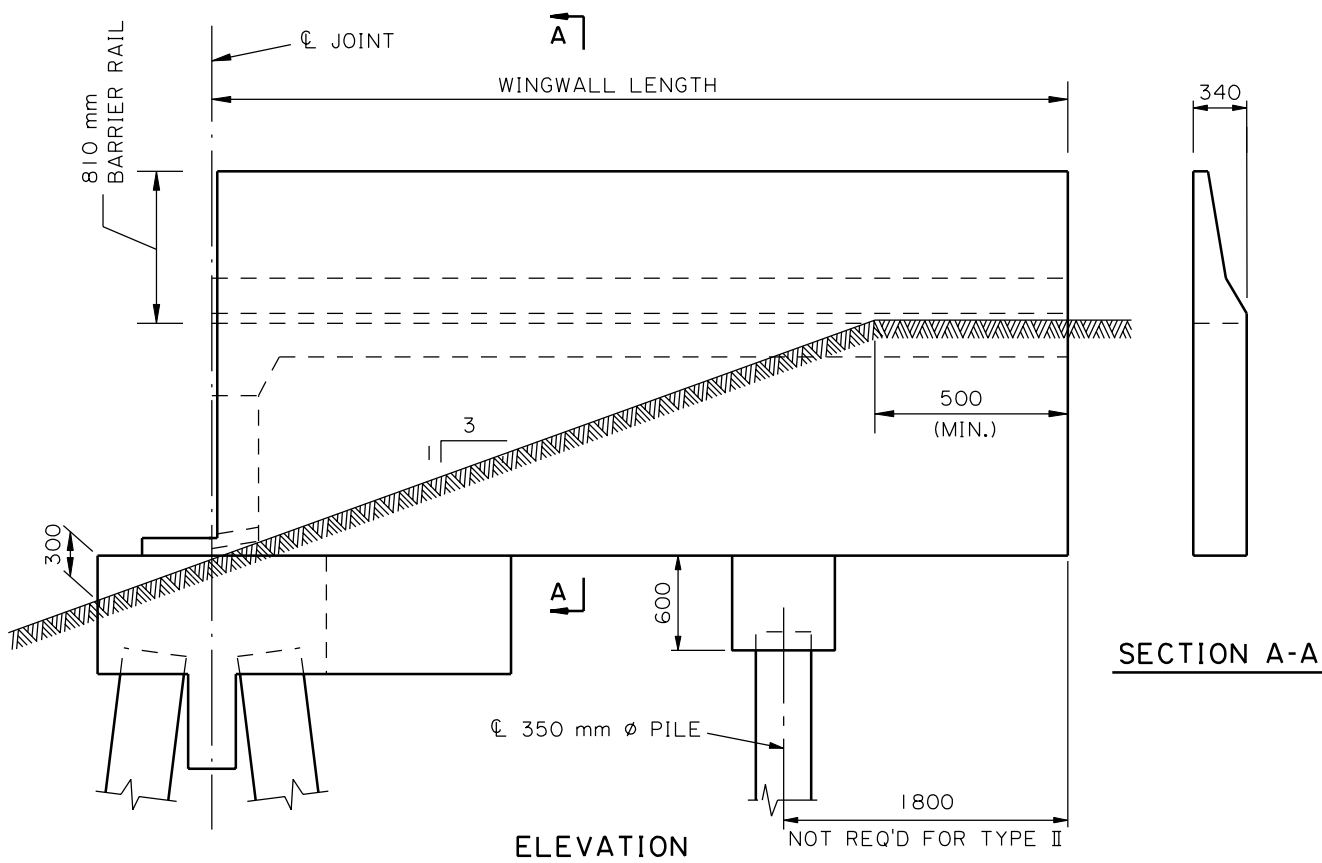
11. The following criteria will be used in determining slab lengths:

On fill sections, use 12 m long approach slab.

On cut sections, use 6 m long approach slab.



PART PLAN



ELEVATION

SECTION A-A

GIRDER TYPE	WINGWALL LENGTH
II	4800
III	5500
IV	6200
BT	7700
IV-M	6700

VALUES SHOWN ARE FOR BENTS ON 90° CROSSINGS WITH EXTERIOR RISERS OF 100 mm. ADJUST LENGTHS AS REQUIRED FOR BENTS WITH HIGHER RISERS AND ROUND UP TO THE NEAREST 100 mm INCREMENT.

WINGWALL DETAILS

SEISMIC REQUIREMENTS

GENERAL

In order to design to resist the effect of earthquake motions, the designer is referred to by AASHTO Standard Specifications for Highway Bridges, Section 3.21 to Division 1-A. The provisions in this section apply to bridges of conventional steel and concrete girder and box girder construction with spans not exceeding 150 m. Suspension bridges, cable-stayed bridges, arch type and movable bridges are not covered.

From the contour map of horizontal Acceleration Coefficients (A) provided in AASHTO's Section 3.2, Louisiana has coefficient values that range from about 2 to 4 percent of gravity. Bridges additionally are assigned an Importance Classification (IC) [Section 3.3]. Based on "A" and "IC", all bridges in Louisiana are placed into Seismic Performance Category (SPC) "A" [Section 3.4].

Category "A" requires the least analysis [Section 4.2] and is covered in Section 5. The two requirements which must be met are:

1. Minimum support length

Provide minimum bearing support length (N) for expansion end of all girders.

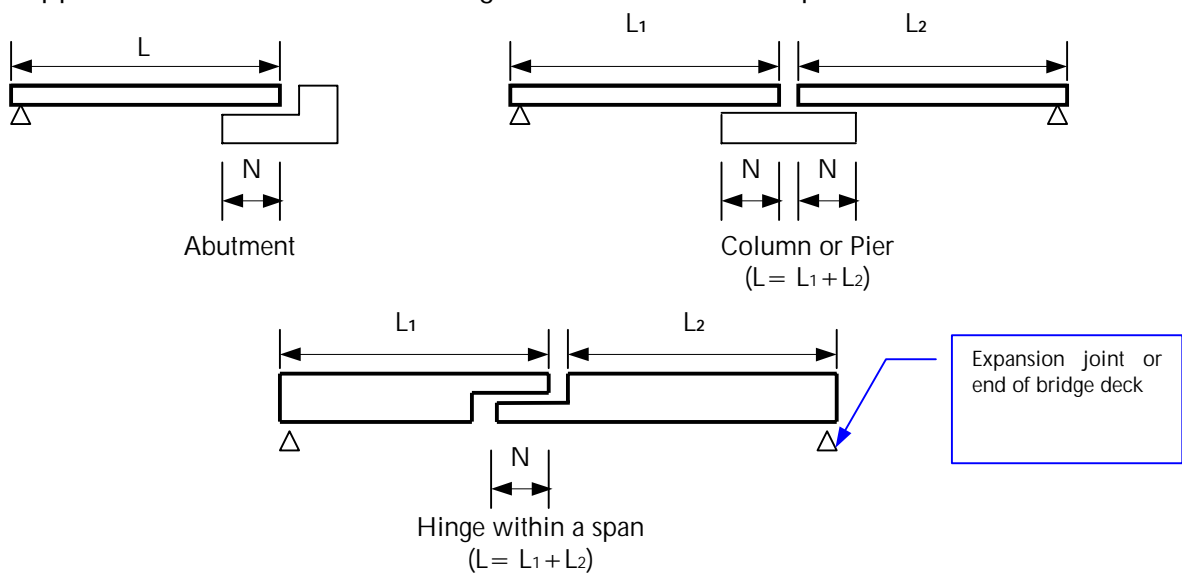
N = Minimum bearing support length for expansion end of all girders in mm.

= $(203 + 1.67L + 6.66H)(1 + 0.000125S^2)$ where

L = Length (m) as shown. (L_1 , L_2 , & L = continuous bridge deck lengths).

H = Average (m) height of columns supporting the bridge deck to the next expansion joint. (Assume distance from bearing elevation to ground fixity).

S = Angle of skew, in degrees, measured from the line connecting bearings along support to a line normal to the longitudinal centerline of span.



DIMENSIONS FOR MINIMUM SUPPORT LENGTH REQUIREMENTS

SHOP DRAWINGS

Introduction

The fabricator prepares shop drawings and erection drawings by interpreting the engineering drawings in the contract plans. The engineer who prepares the engineering drawings shall generally be responsible for checking of the corresponding shop drawings.

Scope

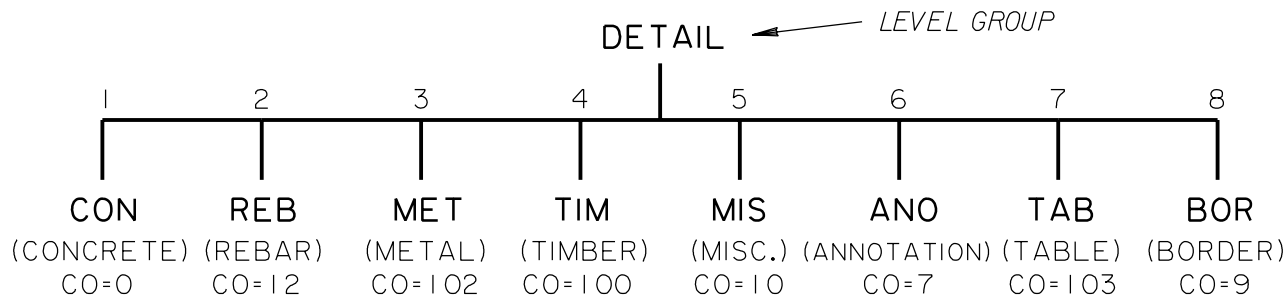
This article covers the responsibilities of the Engineer regarding shop drawings review. The Engineer's responsibilities include two requirements, expediency and completeness, in checking the shop drawings for conformity to contract plans, specifications and special provisions.

Commentary

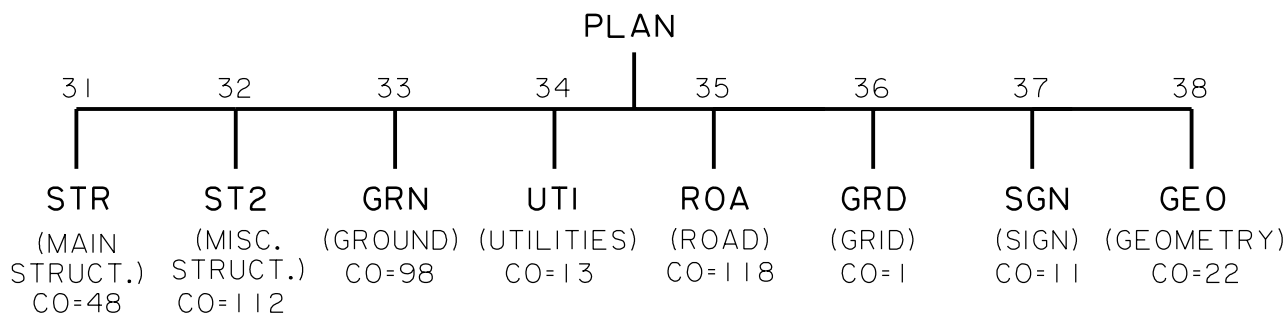
An engineer charged with checking shop drawings for the first time often asks or wonders, "How complete or to what detail should the drawings be checked? The answer to this question is as variable as are the details prepared by the engineer. As the engineer gains experience in checking shop details, he acquires working knowledge of what must be checked and what may be scanned over. The remainder of this article may serve as a guide to the inexperienced checker and a reminder to the experienced engineer.

Guidelines, Shop Drawing Review

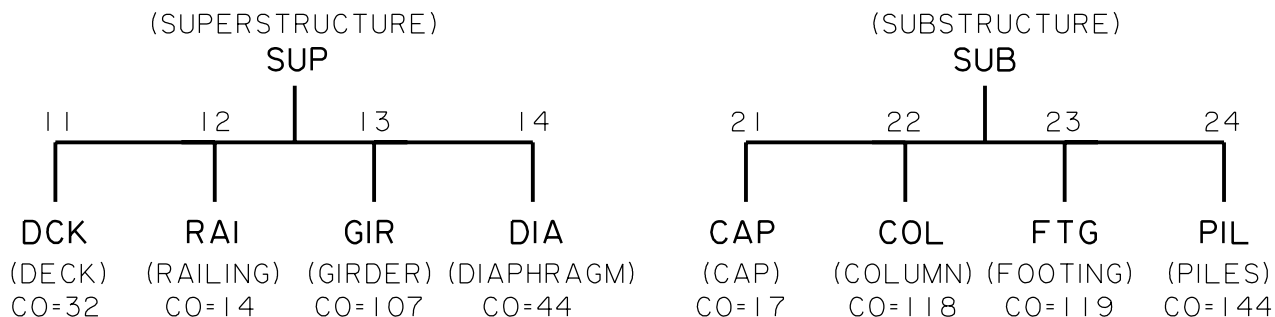
1. Always check shop drawings to the extent you are satisfied that the structure described can be fabricated and erected according to the governing plans and specifications.
2. Shop details shall have top priority unless you are otherwise instructed. This rule is needed to avoid costly delays in the bridge construction.
3. The amount of time to be spent checking shop details should be proportional to their complexity and quantity of sheets involved.
4. For final approval, each shop drawing shall be stamped, initialed, and dated.
5. Shop drawings involving structural steel shall be stamped "Approved for Size of Material and Strength of Connection".
6. Shop drawings involving concrete prestressed girders, and other details shall be stamped "Approved Subject to Satisfactory Installation and Operation".



DESIGN DETAILS



PLANS AND LAYOUTS



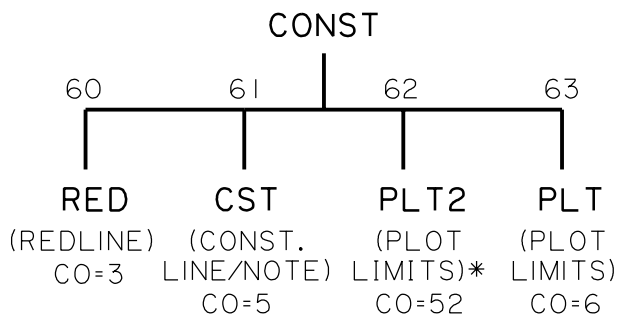
PRELIMINARY WORKING DRAWINGS

NOTES:

STANDARD SEED FILES CONTAIN LEVEL STRUCTURE. WHEN USING DESIGN FILES NOT CREATED FROM SEED FILES, LOAD THE STRUCTURAL LEVEL FILE, STR.LVL, AND SAVE SETTINGS.

FOR CONSISTENCY AND CONVENIENCE, IT IS RECOMMENDED THAT THE SIDEBAR MENU, BR-MI, BE USED TO SET LEVEL AND COLOR.

TOPOGRAPHY LEVELS SHALL BE AS ADOPTED BY THE ROAD DESIGN SECTION. TOPOGRAPHY SHALL BE REFERENCED TO THE PLAN SHEET.



CONSTRUCTION

* CONSULTANT PLOTTING

STRUCTURAL LEVELS

STRUCTURAL METALWORK

APPROACH SLABS:

END DAM PLATE (PL 12x130)	12.25 kg/m
ANCHOR STUDS (M16 x 200 mm)	0.36 kg EACH
CLIP ANGLE (L 203x102x12.7 x 130)	3.80 kg EACH

END BENTS:

ANCHOR BOLTS (STRIP SEAL OR END DAM)

ANCHOR BOLTS (M24 x 510 mm)	1.95 kg EACH
HEX NUTS (2 PER BOLT)	0.18 kg EACH
CUT WASHERS (2 PER BOLT)	0.09 kg EACH

ANCHOR BOLTS (BEARING ASSEMBLY)

ANCHOR BOLTS (M30 x 450 mm)	2.50 kg EACH
HEX NUTS (1 PER BOLT)	0.34 kg EACH
CUT WASHERS (1 PER BOLT)	0.12 kg EACH

INTERMEDIATE BENTS:

ANCHOR BOLTS (BEARING ASSEMBLY)

ANCHOR BOLTS (M30 x 450 mm)	2.50 kg EACH
HEX NUTS (1 PER BOLT)	0.34 kg EACH
CUT WASHERS (1 PER BOLT)	0.12 kg EACH

SPANS:

END DAM ASSEMBLY (WHEN USED)

END DAM PLATE (PL 12x130)	12.25 kg/m
ANCHOR STUDS (M16 x 200 mm)	0.36 kg EACH
CLIP ANGLE (L 152x102x12.7 x 130)	3.13 kg EACH

GIRDERS:

BEARING ASSEMBLY

THREADED INSERTS (2 PER ANGLE)	0.40 kg EACH
CAP SCREWS (M24 x 90 mm) (2 PER ANGLE)	0.40 kg EACH
WASHERS (2 PER ANGLE)	0.09 kg EACH
ANGLE (L 127x127x12.7 x 230)	5.54 kg EACH

ANCHOR BOLTS (STRIP SEAL OR END DAM)

ANCHOR BOLTS (M24 x 300 mm)	1.20 kg EACH
HEX NUTS (2 PER BOLT)	0.18 kg EACH
CUT WASHERS (2 PER BOLT)	0.09 kg EACH

THREADED RODS

ALL THREAD RODS (25 mm ϕ X 965 mm)(EXTERIOR GIRDERS)	3.79 kg EACH
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STRUCTURAL METALWORK WEIGHTS (SUMMARY)

ANALYSIS AND DETAIL INFORMATION

Analysis

1. Ground mounted Multiple post sign supports are considered as cantilever beam-columns that are fully supported against lateral and torsional buckling at sill connections.
2. Ground mounted single post signs are designed as cantilever beam-columns that have unsupported length from the base to the center of pressure of the sign mounted on them.
3. A uniform soil bearing capacity of 143 kPa was used for ground mounted roadside signs.
4. Overhead type II sign trusses are designed as pin connected and simple supported for wind and dead load trusses. The columns for the overhead type II trusses are designed fixed at the base.
5. Structure mounted supports for type II or cantilever overhead sign trusses must be designed and detailed on an individual basis.

Details

1. Ground mounted single-post signs have a breakaway slip base which is beveled such that the sign is given an upward component of acceleration when hit such that the sign will pass over the top of the colliding vehicle without further contact.
2. Ground mounted multiple-post signs have a breakaway slip base which are beveled such that the sign is given an upward component of acceleration when both posts are hit simultaneously. This probability is deemed to exist when the post spacing is 2.1 meters or less.
3. The directional slip bases should be placed such that their operational characteristics will be the most probable direction of high-speed collision where practical.

LOUISIANA PRACTICE

Barriers

Details of several crash- tested roadway barriers have been shown in this chapter. Among these barriers, the double-face thrie beam and the sloped-face concrete barriers are considered by FHWA as "Innovative Barrier". When required by FHWA, these barriers may be used in lieu of the more conventional type.

Barriers shown here are in two basic categories. First, the permanent barriers second the temporary barriers. Temporary barriers are commonly used in construction zone. When temporary barriers are utilized on bridge structures a positive connection to the bridge deck shall be provided, unless it is determined that a considerable lateral deflection of the barrier system can be tolerated. The blunt ends of temporary barriers shall be made crashworthy by means of either an end treatment device or by flaring away from traffic and carrying beyond the clear zone distance.

Guardrail

Virtually all information pertaining to guardrail is contained in the Standard Plan G.R-200(M). This Standard provides information to the designers for the purpose of determining the "Length of Need" and to the contractors, for the purpose of constructing the guardrail.

In addition to G.R-200(M), Standard Plan G.R-201(M) and G.R-202(M) are provided to aid the designers with specific applications of guardrails. By using these particular standards the designers may show the dimensions which are unique to a specific condition on a simple sketch in the contract plans and make reference to a detail on the standard plan to provide the more generic information. Standard plans G.R-201(M) and G.R-202(M) shall always be used in conjunction with Standard Plan G.R-200(M).

Although guardrail standard plans adequately provide the necessary information to construct the guardrail system, it is very important that plans provide all information necessary for the specific site condition. For example, plans shall always show the total length, the length of each pay item, the location, the flare rate, the type of end treatment and any special notes or details.

When bridge construction is considered as "Spot Replacement", often there is little or no road construction, and in such cases minimum guard rail length shall be provided to make the bridge rail blunt ends crashworthy. In these situations, it is not necessary to design "length of need" to provide protection for the full "clear zone" distance behind the bridge rail. An exception to this is when the existing road in the vicinity of the structure provides the design "clear zone" distance, in which case the guardrail for the bridge ends shall provide protection consistent with that "clear zone" distance. The decision whether the minimum length or the standard length is to be utilized shall be made at the Plan-In-Hand meeting after the road condition is examined. The final decision shall be included in the